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# REPORT

OF THE

# TESTS OF METALS

AND

# OTHER MATERIALS

FOR

# INDUSTRIAL PURPOSES

MADE WITH THE

UNITED STATES TESTING MACHINE AT WATERTOWN ARSENAL, MASSACHUSETTS,

DURING

THE YEAR ENDED JUNE 30, 1882.

WASHINGTON:
GOVERNMENT PRINTING OFFICE.
1883.

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47TH CONGRESS, 2d Session. | SENATE. | EX. DOC. No. 1.

# LETTER

FROM

# THE SECRETARY OF WAR,

TRANSMITTING

*A report of the tests of iron and steel and other materials for industrial purposes, made with the United States testing machine during the fiscal year ended June* 30, 1882.

DECEMBER 5, 1882.—Ordered to lie on the table and be printed.

WAR DEPARTMENT,
*Washington City, December* 4, 1882.

The Secretary of War has the honor to transmit to the United States Senate a letter from the Chief of Ordnance, United States Army, dated November 15, 1882, accompanied with the report of the commanding officer of Watertown Arsenal of the tests of iron and steel, and other materials for industrial purposes, made with the United States testing machine during the fiscal year ended June 30, 1882.

Attention is invited to the recommendations that section 3709 Revised Statutes of the United States be so modified as to exempt the procurement of material for tests from the operation of its requirements, and that authority be given by Congress for the frequent publications of the results of tests in order that information of such great value may be quickly disseminated; also to the recommendation that five hundred additional copies of the accompanying report be ordered printed for the use of the Ordnance Office; all of which recommendations are concurred in by this Department.

ROBERT T. LINCOLN,
*Secretary of War.*

The PRESIDENT *pro tempore*,
*United States Senate.*

ORDNANCE OFFICE, WAR DEPARTMENT,
*Washington November* 15, 1882.

SIR: I have the honor to submit herewith, for transmission to Congress, as required by law, the report of the commanding officer of Watertown Arsenal of the tests of iron and steel, and other materials for industrial purposes, made with the United States testing machine during the fiscal year ending June 30, 1882.

Attention is invited to the recommendation that the law (section 3709

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Revised Statutes) requiring the procurement of supplies by contract after advertisement be so modified as to enable this Department to procure materials for tests in open market. The reasons for this are briefly given in this report. Under this section purchases in open market can only be made when the public exigency requires the immediate delivery. The "public exigency" is therefore one of time only, and it has been so construed by the Attorney-General. I respectfully recommend that section 3709 be so modified as to exempt the procurement of material for tests from the operation of its requirements.

It is urgently recommended that Congress be asked to authorize frequent publications of the results of tests—monthly if possible—that information of such great value may be quickly disseminated. The present report of date August 31, 1882, will hardly issue from the Public Printer before next spring, at the very earliest—many months subsequent to the time when the results were obtained and ready for use.

I have also to recommend that Congress be asked to have printed five hundred additional copies of this report for the use of this office. The calls for it are many and constant, and this Bureau should be in condition to supply a limited number to those most interested.

Very respectfully, your obedient servant,

S. V. BENÉT,
*Brig. Gen., Chief of Ordnance.*

The Hon. SECRETARY OF WAR.

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# REPORT

OF

# TESTS OF METALS FOR INDUSTRIAL AND OTHER PURPOSES.

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WATERTOWN ARSENAL, *August* 31, 1882.

SIR: I have the honor to report that during the fiscal year ended June 30, 1882, the testing machine at this arsenal has been kept busily at work in making tests for private parties and for industrial purposes agreeably to the provisions of the acts of Congress governing its use.

There have been tested during the year 1,587 specimens in all, of which number 855 were for private parties, and 664 were on Government account; the former occupied 97 days, and the latter 208 days. The private parties having work done were 33 in number, 2 of which were from Maine, 17 from Massachusetts, 3 from Rhode Island, 3 from New York, 2 from New Jersey, 4 from Pennsylvania, 1 from Michigan, and 1 from Kansas.

The specimens tested for private parties were by no means so large, the most of them, that they could not be tested on private machines of smaller capacity; many specimens were of quite moderate size, but the parties having tests to make seem to prefer to have the work done on the Government machine, having great confidence in the accuracy of its determinations and the care and faithfulness with which the work is performed.

Since the 9th of March, 1882, the date of your order directing that all money received for making private tests be covered into the Treasury instead of being used to pay the expenses of making such tests, as had formerly been done, there has been turned into the Treasury on this account the sum of $972.84. In addition to this the sum of $2,628.78 was turned into the Treasury from the appropriations of 1881 for making tests for industrial purposes, this being the amount of contracts entered into for materials which were not delivered according to agreement, within the stipulated time; and of the money appropriated for the last fiscal year the sum of $606.76 was covered into the Treasury on account of similar failures of parties to comply with the terms of their contracts. Thus of the moneys appropriated for making tests for industrial purposes $4,208.38 have not been used, but have been returned to the Treasury, mainly because of the want of promptness of contracting parties in furnishing materials for specimens to be tested agreeably to the terms of their contracts. This strict adherence to rules involving the rejection of material simply for the reason that it was not delivered at the time agreed upon, well enough in its way, causes great delays in executing work which is of great importance to the country; and for this and other reasons it is respectfully urged that the system of procuring materials to be tested may be modified so as to allow greater facilities for obtaining the exact kind of material wanted. This subject will be reverted to again before the close of this report.

The tests made during the last year have been mainly on riveted joints, and on the resistance of white and yellow pines to forces of compression in the direction of the fiber, or as used for columns, or posts. This resistance is given in various works on the subject, as it has

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been determined by different experimenters. The question to be determined was whether or not the information which we have on this point will serve as a safe and reliable rule for engineers to base their calculations on, in the construction of a bridge or building.

To solve this problem a large quantity of white and yellow pine was purchased in market; the conditions to be fulfilled were that the timber should be sound, free from sap, large and loose knots. It was procured in April, 1881, the white pine mostly from New Hampshire, with some from Michigan, and was stored for more than a year in a dry, well-ventilated store-house, after which it was tested as single and compound columns composed of two, three, and four sticks, bolted together with keys of different thickness interposed, sometimes with different thickness in the same column, giving it a swell at the middle; 191 tests of full-sized columns were made; the most of them were of the same length, 15 feet; the pieces were dressed, and the ends squared with care, so as to give an even bearing; they were first weighed, the rings of growth counted, the grain noted, whether straight or not, and placed in the machine in a horizontal position with the greater depth vertical, so that the weight of the column should have no effect in determining its deflection; the elastic limit, in compound columns, was first determined of the pieces separately, which were afterwards assembled, and the load increased gradually till failure took place.

When only a limited number of tests have been made with carefully selected sticks of small size, there is no trouble experienced in drawing definite conclusions therefrom; but as the tests increase in number and the size of the specimens becomes larger, the difficulty of drawing conclusions increases, and with a large number of tests of specimens of large size, and with the ordinary imperfections of the timber, it is almost impossible to draw any general conclusions applicable to all timbers. It was found that the average load for sticks as large as those used was about one-half of that which is ordinarily given as the ultimate load for these woods; that the weak points are the knots, and in pieces which yield by the crushing of the fibers failure always takes place at the knots; in pieces of greater length the effect of knots is less felt, and it cannot be clearly demonstrated to what extent they influence the resistance of the column; and in very long columns, unless the knots occur near the middle of the length, they seem to have no appreciable effect in determining the direction of flexure. Some sticks were tested a second time after the lapse of a year or more, and in all cases a diminution of strength was observed on the second trial.

A second series of tests was made on yellow pine, each increment of the load being permitted to remain for five minutes and then removed, measuring the set caused thereby. Curves have been plotted showing the effect of this continuance of the load, and the effect becomes more apparent as the ultimate strength of the timber is approached.

In compound columns care should be exercised in selecting the sticks which are to form the column; of course it would be useless to place a poor with a strong stick, but it is best to place the good together and the inferior by themselves. No attention was at first paid to this disposition until experience showed the advantage to be gained by its observance.

To make the effect of knots in the resistance of short posts to compression more apparent, some columns, after having been tested and their resistance determined, were cut up and specimens of shorter lengths taken and tested; the difference in the strength was very marked, as was to be expected. An oak column 168 inches long, which yielded at 4,953 pounds per square inch, showed in a specimen 32 inches long

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cut therefrom 8,450 pounds per square inch, and another 7,794 pounds per square inch, which then gave way at a knot. Another post, 164 inches long, failed at 3,432 pounds per square inch, but a piece 32 inches long was cut from it which gave 6,230 pounds per square inch. A yellow-pine post 143 inches long gave a resistance of 4,663 pounds per square inch, but a specimen 32 inches long was taken from it which had a resistance of 6,230 pounds per square inch. Pieces of smaller size could doubtless have been cut from each of these which would have shown still greater strength, as they might have been obtained more free from imperfections of all kinds. Knots of even small size, firm and sound, exercise an injurious effect upon the strength of timber. This was shown in a piece of spruce from which two samples were cut—one having a uniform, straight grain, the other two small knots; the strength of the former was 11 per cent. greater than the latter. A photograph gives some idea of the apparent insignificance of the knots in this case.

When we come to determine the resistance of specimens having knots to forces of compression at right angles to the fibers of the wood, we find the resistance much increased, and this increase should be taken into account when selections for this purpose are possible. The resistance of specimens of a given wood as compared with others of its kind is generally indicated by its specific gravity, but this does not always hold good. In yellow pines, some of those rich in turpentine have a high specific gravity and yet are not the strongest. The rapidity of growth will sometimes give indications of the strength. A rapid growth in oak is apt to be accompanied by an increase of strength, while the reverse is often true in yellow pine.

### RIVETED JOINTS.

Testing-machines in general have not been arranged to hold conveniently and rigidly flat plates of considerable width, and consequently there are on record no great number of tests giving the proportions of resistance of such joints to the area of cross-section of metal. With the view of determining the much-needed data on this subject, both as applied to boilers, bridges, and similar structures, I instituted an extended series of experiments, commencing with the tests of ordinary specimens of the material used to determine its tensile strength and to serve as a standard of comparison for all of the succeeding tests. Afterward grooved specimens, 146 in number, were tested. At first the area of cross-section remained constant, the size of the groove varying from $\frac{1}{4}$ inch to $\frac{3}{4}$ inch, and then the area was increased. Of these preparatory tests 214 were made.

Experiments were instituted to determine the amount of friction that is caused by the pressure with which one plate is forced against its neighbor by the riveting. Iron and steel plates $\frac{1}{4}$ and $\frac{3}{8}$ inches were used, held together first with one rivet and afterwards with five rivets; and the shearing strength of the rivets determined. More than 100 tests have been made of single-riveted lap-joints of plates $\frac{1}{4}$, $\frac{3}{8}$, $\frac{1}{2}$, $\frac{5}{8}$, and $\frac{3}{4}$ inch, both of iron and steel, and double-riveted lap-joints with $\frac{1}{4}$ and $\frac{3}{8}$ inch plates, and single-riveted lap-joints, with a reinforced welt, with plates of $\frac{3}{8}$ inch, both iron and steel.

A portion of a locomotive boiler which had been in service for twenty-four years was obtained from one of the railroad companies with the view of determining in what way it compared with boilers made at this time. So far as could be detected by examination it had undergone no marked change, but when subjected to stress it showed a grooving of about $\frac{1}{4}$ inch deep. A photograph of the specimen was taken to show

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the thickness to which the metal was reduced by this long-continued action.

MISCELLANEOUS TESTS.

Some iron bars which had been previously tested and showed a mean ultimate strength of 52,034 pounds per square inch, were tested again after an entire rest from eight to ten months. The mean ultimate strength after rest was 62,146 pounds per square inch. Such a bar was heated to a cherry-red heat and permitted to cool, when it was tested, and broke at 39,700 pounds per square inch, showing that the increase of strength gained by previous stress was lost by the reheating, and the iron had ceased to be as strong as it originally was.

Some 2-inch round bars of single and double refined iron which could not be tested last year for the want of proper means to hold the bars, have been tested, and show that the ultimate strength of the product of one mill was slightly less for the single refined than the double, and of the other the strength was greater.

Wrought iron I-beams have been tested to give their resistance when used as columns; and some short columns with one pin and one flat end, remnants of columns on hand, have been tested for compression.

With the means at my disposal I am able to give merely the results obtained by the testing machine. I have not the means of working up these results to show more clearly their bearing, and fit them for the practical use of others.

The provision made in the machine for holding flat bars of moderate size, or specimens of plate, are all that can be desired, but the conveniences for testing round bars of all sizes are not so perfect. The specimen, if it be of a ductile material, is diminished in size, and as the holder does not follow up the action of the specimen, the latter is not held so firmly as at first, and finally is liable to slip in the die. The importance of being able to test specimens of round bars of all sizes just as they come from the mills, was deemed so urgent that I proceeded at considerable expense to add to the machine this important and necessary part. It is made throughout of steel, and from the experience thus far had with it there seems to be little doubt of its answering the desired purpose admirably well. As yet I have prepared only a single set of dies for 2-inch bars; others will have to be added as the necessities require and the funds will permit. The cost of this new holder has been $1,309.

Mr. James E. Howard, who has had the immediate charge of the machine and of the tests made thereon, has performed his laborious duties in a manner highly acceptable to myself and the private parties who have had occasion to make use of the machine. His intelligent interest in the work, the care that he takes to insure entire accuracy of results, his quickness to observe all that takes place, and the skill with which he manages the machine, are a sure guarantee for the perfect reliability of the results obtained, and persons who have been present at the tests of their own materials, to see for themselves that every precaution is taken to insure accuracy, have expressed themselves as entirely satisfied in every particular with the manner of conducting the work.

I am indebted to Capt. John Pitman, Ordnance Department, for the chemical analysis of certain specimens of iron and steel, and for the photographs and drawings which serve to illustrate this report. The labor of preparing the latter has been performed by him cheerfully, though it has not been customary to require such work, week after week,

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from an officer of his rank; no alternative, however, was left me, for when I asked for authority to procure the services of a draughtsman and computer for this purpose, I was told to call upon my officers to perform those duties. From this it might be argued that a high estimate was not placed on the services of the officers of the Department. I cannot believe that the Government consults its best interests by such assignments of its officers to duty. Captain Pitman can, in my opinion, be better employed than as a draughtsman, accomplished as he is in this particular. I am indebted to Mr. Joseph M. Wilson, C. E., engineer of the bridges and buildings of the Pennsylvania Railroad, and W. S. Thompson, C. E., for suggestions in regard to the tests, the former of riveted joints for bridges, &c., and the latter of wooden columns or posts. I appreciate the interest that these engineers have taken in this work, and have profited by their suggestions.

In my last year's report I proposed to add to this machine the necessary fixtures to enable me to make tests of torsion, and measure the transverse resistance of materials on this machine. Further experience convinces me that in place of changing this machine to adapt it to these several kinds of work it would be better to make new machines for these purposes and retain the present for those tests for which it is so well adapted. The only objection that has come to my knowledge in relation to the tests made by the Government on this machine is the expense attending them. This has been urged only by those who have had very long specimens to test; and in order to do this work extensive changes had to be made in the machine to prepare it for the extraordinary demand made upon it. It requires a half day and the services of three additional men to remove the holders from their normal position so as to take in these long specimens; and when, as it often occurs, they have considerable ductility, the time required to follow up a stretch of 40 inches or more, as has been necessary in some cases, and to rupture the specimen, necessarily makes the expense proportionately great. If, as in other machines, only specimens of nearly one size were tested, this expense of shifting from kinds of work widely dissimilar would not be required; but just in proportion as the machine is made to do a greater variety of work, so will the cost of doing this work be increased from the necessity of making greater changes in the machine to adapt it thereto. In the selection by a certain party of a machine on which to do some extensive work of testing, outside considerations made it desirable that another machine than that of the Government should be chosen. Examination of both machines was made, with the view of determining which should be finally chosen; and the result of the investigation led to the selection of the Government machine, as the choice of any other would involve too great a sacrifice of time and convenience to render it admissible. The wisdom of the choice has been made apparent by both the quantity of work as well as its quality; as many as 80 tests having been made in one day, when the specimens varied only slightly and many measurements were not required.

It almost always happens that a combination machine is made such at the sacrifice of some one or more important feature, and to attempt to engraft on the testing machine now on hand, which will have work enough to keep it busy for years to come, the means of making transverse and torsional tests, will result in providing means of making transverse and torsional tests inadequate to the wants of the country, and will further complicate the machine so as to increase the labor of adapting it to these various kinds of work and thereby proportionally add to

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the cost. I would therefore respectfully recommend that, instead of changing this machine to adapt it to perform any new service, it be retained for the uses for which it is at present prepared, and that new machines be built for testing transversely and by torsion. We shall then have the most complete means of performing economically the several tests to which it is desirable to subject materials according to the use or purpose for which they are intended, and this course will in the end prove not only the most convenient but also the most economical and satisfactory.

There are one or two points in regard to which it is highly desirable that there should be some special legislation to render it possible to carry on this work to the best advantage. And first, in regard to the procurement of materials. The law requiring the contract for supplies furnished to be given to the lowest bidder renders it impossible at times to procure just the kind of materials which it is desirable to test. I have just been testing the white and yellow pines as they are found in our markets. Of these woods we know next to nothing, where they grew, when they were cut, of what varieties they are, what kind of soil furnished them, &c. It is highly important that we should make tests of timber in large pieces cut from trees, the complete history of which we can be perfectly sure of. This is not possible without some change in the law directing how purchases shall be made.

So, again, it is desirable that we should test specimens of iron and steel made from certain ores, the history of which and the product in all of its details we shall have full and complete knowledge of. How can we have this when we must purchase of the lowest bidder and take his word only that we shall have what we require?

Again, it is desirable that we shall have the means of printing the results of the tests without waiting some two years to have it done as at present; and we also much need the means of disseminating this information where it is most wanted and most highly appreciated. There is information in this report of great interest and value to certain industries which will be kept in ignorance of it for two years or more after the tests were made, when the parties could, by a different system of publication, not practicable without new legislation, have been in possession of the main facts almost immediately after the facts were determined.

Applications are constantly made to me for copies of the reports of the tests which have been already made. It would seem to be a very proper arrangement to place a given number of those reports at the disposal of the officer having charge of the making of the tests, to be disposed of on the payment of a fixed price, to enable those who have an interest in knowing about the tests to procure at a moderate expense the detailed report of them.

I would again recommend that specimens which have been tested may be sold, and the proceeds used in procuring other materials for similar purposes, a report, of course, of all such sales to be made to Congress. The money appropriated for the testing of materials for industrial purposes, so far as it has been spent, it is believed has been expended judiciously, economically, and for the purposes for which it was appropriated. The results obtained will be appreciated most by those who know most of the wants that are thereby filled, who are most conversant with the subject considered. A larger sum of money than has heretofore been granted by any annual appropriation can be expended to great advantage to the country at large in carrying on these tests. This is a matter in which all are more or less intimately con-

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cerned, as all are interested in the safety of our bridges, public buildings, locomotive and steamboat boilers, &c., which may be made by the aid of such information as can only be obtained from such tests as are here referred to, both safer and more reliable, and at the same time less expensive than at present.

Money is freely and wisely given for the dissemination of useful practical knowledge in regard to any of the various branches of agriculture, but the people are as much interested in the development of our immense mineral resources and the improvement of our manufactured productions as in those of the soil. Valuable information furnished in reference to the former will repay as surely and promptly the cost attending its determination and dissemination as the latter. An enlightened policy demands liberality in expenditures for each of these purposes, for the public need is as intimately connected with the sure, steady, and rapid development of the one as the other.

Very respectfully, your obedient servant,

T. T. S. LAIDLEY,
*Colonel of Ordnance, Commanding.*

The CHIEF OF ORDNANCE.

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## REMARKS ON RIVETED JOINTS.

This series of tests comprises the tensile tests of joints with plates having a nominal thickness of $\frac{1}{4}''$, $\frac{3}{8}''$, $\frac{5}{8}''$, and $\frac{3}{4}''$ of wrought iron and open hearth steel.

The tensile test of the material itself for each thickness of plate.

In $\frac{1}{4}''$ plates was determined the strength of grooved specimens, the resistance to shearing out at rivet holes, and shearing parallel to the grain of the metal. Experiments upon the friction of rivets are given. The wrought-iron plate was furnished by one maker out of one quality of stock.

The steel plates were supplied from one heat cast in ingots of the same size, the thin plates differing from the thicker plates only in the amount of reduction given the metal by the rolls.

All joints have machine-driven rivets unless otherwise stated in the detailed notes. "Burden's best" iron rivets used; steel rivets made of mild steel of about the same quality as employed for boiler plates.

The joint plates have planed edges; except where calked the metal was first planed and then chipped to a beveled edge. Elongations were measured within a gauged length of 10″ including and symmetrical with the center line of the joint. An exception to the above location of the gauged length is found with the $\frac{1}{4}''$ iron butt joints, where the 10″ gauged length began at a point on the center line of the welt and included only one row of rivets.

The recorded elongations show the slip of the joint plus the elongation of the plates.

The modulus of elasticity of the metal was found: Iron plate, 31,970,000 pounds; steel plate, 28,570,000 pounds.

The space between the testing-machine jaws was kept at 24″. Joints were adjusted in the jaws to compensate for the offset of the lap. As loads were applied observations were made to determine the amount of distortion indicated by the opening of the joint at the calked edge.

In the tabulated results the manner of fracture is shown by sketches of the joints, and is further indicated by underscored figures in columns headed: Maximum strains on joint, pounds per square inch.

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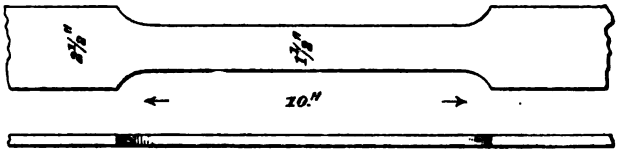
## TENSILE TESTS OF WROUGHT-IRON PLATE.

*Material used in riveted joint tests.*




| Number of test. | Nominal thickness. | Direction of grain. | Actual dimensions. | | Sectional area. | Elastic limit. | | Ultimate strength. | | Elongation in 10 inches. | Uniform elongation. | Area at fracture. | Contraction of area. | Appearance of fracture. | Remarks. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Thickness. | Width. | | Actual pounds. | Pounds per square inch. | Actual pounds. | Pounds per square inch. | | | | | | |
| | *In.* | | *Inch.* | *Inches.* | *Sq. in.* | | | | | *Perct.* | *Perct.* | *Inches. Sq.in.* | *Perct.* | | |
| 440 | | Lengthwise | .257 | 1.515 | .389 | 14,150 | 36,370 | 18,810 | 48,350 | 17.0 | 16 | .21 x 1.48=.300 | 22.9 | Fibrous lamellar. | Hammered cold before testing with 6-pound hammer, stretching metal ".16 in 10"=1.6 per cent. Rapid stretching began at 44,920 pounds per square inch. |
| 441 | | ..do | .238 | 1.514 | .360 | 12,980 | 36,050 | 17,100 | 47,500 | 16.8 | 16 | .20 x 1.43=.286 | 20.6 | ....do | |
| 442 | | ....do | .260 | 1.516 | .394 | Not obtained. | | 20,280 | 51,470 | 8.4 | 7 | .20 x 1.48=.296 | 24.9 | ....do | |
| 443 | | Crosswise | .265 | 1.500 | .397 | 10,200 | 25,700 | 15,150 | 38,160 | 4.5 | 4 | .25 x 1.46=.365 | 8.1 | ....do | |
| 444 | | do | .266 | 1.500 | .399 | 9,900 | 24,810 | 15,100 | 37,840 | 4.0 | 3 | .25 x 1.47=.367 | 8.1 | ....do | |
| 77 | | Lengthwise | .375 | 1.494 | .560 | 18,300 | 32,679 | 26,650 | 47,590 | 13.6 | 12 | .32 x 1.42=.454 | 18.9 | Fibrous, marked lamination. | Hammered cold before testing, stretching metal ".15 in 10". |
| 78 | | ....do | .377 | 1.495 | .564 | 17,200 | 30,496 | 26,380 | 46,773 | 10.8 | 10 | .34 x 1.43=.486 | 13.8 | ... do | |
| 79 | | ....do | .376 | 1.496 | .562 | 20,800 | 37,010 | 27,250 | 48,488 | 5.0 | 2 | .34 x 1.47=.500 | 11.0 | .. do | |
| 255 | | Lengthwise | .515 | 1.500 | .773 | 19,400 | 25,100 | 33,550 | 43,400 | 11.4 | 10 | .44 x 1.41=.620 | 19.8 | Fibrous | Hammered cold before testing, stretching metal ".19 in 10". |
| 256 | | ....do | .511 | 1.503 | .768 | 19,800 | 25,789 | 35,200 | 45,830 | 13.8 | 13 | .45 x 1.41=.635 | 17.3 | ....do | |
| 257 | | ....do | .501 | 1.502 | .752 | Not well defined | | 38,800 | 51,600 | 4.5 | Irregular. | .44 x 1.49=.656 | 12.8 | ....do | |
| 310 | | Lengthwise | .621 | 1.496 | .929 | 24,500 | 26,370 | 40,900 | 44,030 | 10.3 | 10 | .55 x 1.44=.792 | 14.8 | Fibrous dull | Hammered cold before testing, stretching metal ".15 in 10". |
| 311 | | ....do | .621 | 1.505 | .935 | 23,800 | 25,450 | 42,300 | 45,240 | 12.4 | 12 | .55 x 1.43=.787 | 15.8 | ....do | |
| 312 | | ....do | .627 | 1.497 | .939 | Not well defined | | 44,700 | 47,600 | 4.9 | ..... | .56 x 1.50=.825 | 12.1 | .. do | |
| 313 | | Lengthwise | .696 | 1.505 | 1.047 | 29,200 | 27,890 | 48,950 | 46,750 | 12.8 | 11 | .61 x 1.42=.866 | 17.3 | Fibrous dull | Hammered cold before testing, stretching metal ".15 in 10". |
| 314 | | ....do | .694 | 1.495 | 1.038 | 27,450 | 26,440 | 48,200 | 46,430 | 13.8 | 11 | .61 x 1.39=.848 | 18.3 | ... do | |
| 315 | | ....do | .696 | 1.492 | 1.038 | Not well defined | | 53,250 | 51,300 | 7.0 | ..... | .59 x 1.49=.880 | 15.2 | ... do | |

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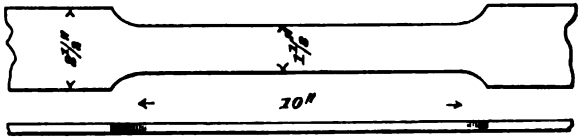
## TENSILE TESTS OF O. H. STEEL PLATE.

*Material used in riveted joint tests.*




| Number of test. | Nominal thickness. | Actual dimensions. Thickness. | Actual dimensions. Width. | Sectional area. | Elastic limit. Actual pounds. | Elastic limit. Pounds per square inch. | Ultimate strength. Actual pounds. | Ultimate strength. Pounds per square inch. | Elongation in 10 inches. | Uniform elongation. | Area at fracture. | Contraction of area. | Appearance of fracture. | Remarks. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | *In.* | *Inch.* | *Inches.* | *Sq. in.* | | | | | *Perct.* | *Perct.* | *Inches. Sq. in.* | *Perct.* | | |
| 397 | | .247 | 1.515 | .374 | 14,700 | 39,440 | 20,940 | 56,000 | 26.7 | 20 | .13 x 1.24=.161 | 57 | Silky | Hammered cold before testing, stretching metal ".15 in 10". |
| 398 | | .244 | 1.513 | .369 | 15,600 | 42,280 | 20,490 | 55,530 | 24.2 | 20 | .14 x 1.16=.162 | 56.1 | ...do | |
| 399 | | .250 | 1.51 | .378 | 15,000 | 39,680 | 22,060 | 58,360 | 19.2 | 13 | .11 x 1.28=.141 | 62.7 | Fine silky | Hardened specimen heated cherry-red and plunged into cold water. |
| 400 | | .248 | 1.512 | .375 | 17,800 | 47,170 | 27,900 | 74,400 | 13.4 | 8 | .12 x 1.31=.157 | 58.1 | ...do | |
| 72 | | .375 | 1.502 | .563 | 19,500 | 34,636 | 29,300 | 52,042 | 28 6 | 24 | .20 x 1.04=.208 | 63.1 | Fine silky | Hammered cold before testing, stretching metal ".11 in 10". |
| 73 | | .377 | 1.492 | .562 | 18,200 | 32,384 | 29,400 | 52,313 | 27.8 | 21 | .21 x 1.03=.216 | 61.5 | ...do | |
| 74 | | .375 | 1.500 | .563 | 17,800 | 31,616 | 30,250 | 53,730 | 26.6 | 18 | .21 x 1.08=.227 | 59.7 | ...do | |
| 75 | | .373 | 1.498 | .559 | 17,800 | 31,810 | 30,200 | 54,025 | 27.1 | 21 | .20 x 1.04=.208 | 62 8 | ...do | |
| 76 | | .372 | 12.000 | 4.46 | 141,000 | 31,610 | 245,000 | 54,930 | ..... | 17 | .19 x 10.06=.191 | 57.2 | Silky | |
| 252 | | .500 | 1.490 | .745 | 23,200 | 31,140 | 42,200 | 56,640 | 29.2 | 24 | .30 x 1.06=.318 | 57.3 | Silky | Hammered cold before testing, stretching metal ".16 in 10". |
| 253 | | .501 | 1.499 | .751 | 23,500 | 31,290 | 43,400 | 57,790 | 26.1 | 20 | .33 x 1.09=.360 | 52.1 | ...do | |
| 254 | | .496 | 1.500 | .744 | 33,500 | 45,030 | 43,180 | 58,040 | 23.0 | 19 | .29 x 1.15=.333 | 55.2 | ...do | |
| 304 | | .621 | 1.504 | .934 | 29,980 | 32,100 | 49,100 | 52,570 | 29.0 | 24 | .35 x 1.00=.350 | 62.5 | Silky | Hammered cold before testing, stretching metal ".15 in 10". |
| 305 | | .621 | 1.495 | .928 | 31,300 | 33,730 | 48,530 | 52,320 | 28.2 | 21 | .35 x 1.00=.350 | 62.3 | ...do | |
| 306 | | .621 | 1.500 | .932 | Not well defined. | | 49,600 | 53,220 | 27.1 | 18 | .33 x 1.07=.353 | 62.1 | ...do | |
| 307 | | .731 | 1.500 | 1.097 | 33,850 | 30,860 | 56,400 | 51,410 | 29.5 | 22 | .39 x .96=.374 | 65.9 | Silky | Hammered cold before testing, stretching metal ".15 in 10". |
| 308 | | .734 | 1.502 | 1.102 | 33,550 | 30,440 | 56,950 | 51,680 | 28.7 | 22 | .41 x .96=.394 | 64.3 | ...do | |
| 309 | | .730 | 1.500 | 1.095 | Not well defined. | | 57,250 | 52,280 | 28.6 | 25 | .37 x 1.04=.385 | 64 8 | ...do | |

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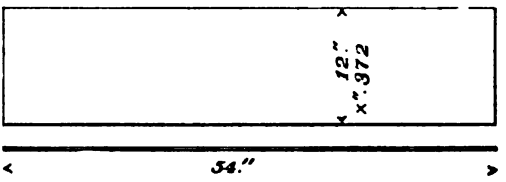
No. 76.

TENSILE TEST, $\frac{3}{8}$" STEEL PLATE.




Sheet stamped T. S., 60,000 pounds.
Sectional area, 4.46 square inches.
Gauged length, 20".
Free length of specimen between holders, 32".

| Loads applied. | Pounds per square inch. | Elongation. | Permanent set. | Remarks. |
|---|---|---|---|---|
| *Pounds.* | | *Inch.* | *Inch.* | |
| 4,460 | 1,000 | 0. | | |
| 22,300 | 5,000 | .0025 | | |
| 44,600 | 10,000 | .0060 | | |
| | 1,000 | | 0. | |
| 66,900 | 15,000 | .0095 | | |
| 89,200 | 20,000 | .0130 | | |
| | 1,000 | | 0. | |
| 111,500 | 25,000 | .0165 | | |
| | 1,000 | | 0. | |
| 118,000 | | .0178 | | |
| 123,000 | | .0182 | | |
| 125,000 | | .0188 | | |
| 127,000 | | .0190 | | |
| 129,000 | | .0191 | | |
| 131,000 | | .0195 | | |
| 133,800 | 30,000 | .0200 | | |
| | 1,000 | | 0. | |
| 135,000 | | .0202 | | |
| 137,000 | | .0205 | | |
| 139,000 | | .0208 | | |
| 141,000 | 31,610 | .0212 | | Elastic limit. |
| 143,000 | | .0255 | | |
| 145,000 | | .0480 | | |
| 147,180 | 33,000 | .0800 | | |
| 151,640 | 34,000 | .14 | | |
| 156,100 | 35,000 | .38 | | |
| 178,400 | 40,000 | .60 | | |
| 200,700 | 45,000 | .94 | | |
| 223,000 | 50,000 | 1.58 | | |
| 245,000 | 54,930 | | | Ultimate strength. |
| 0 | 0 | 8.70= | | 18.5 per cent. |

Elongation of inch sections, ".14, ".14, ".14, ".14, ".15, ".15, ".16, ".16, ".16, ".16, ".16, ".16, ".17, ".17, ".17, ".17, ".17, ".17, ".18, ".19, ".20, ".21, ".23, ".25, ".29, ".34, ".44, ".57, ".96, ".38.

Minimum width at fracture, 10".06.

Average thickness at fracture, ".19.

Area at fracture, 1.91 square inches. Contraction of area, 57.2 %. Silky fracture. The specimen varied in thickness; the elastic limit was passed in the minimum section first. Fracture occurred at the smaller end, and the elongations show the greatest stretch at this end.

When the "Cooper lines" were first developed some appeared at right angles to the axis of the specimen; others followed in diagonal lines from each edge, intersecting each other.

The diagonal lines make an angle of 56° 20′ with the axis of the specimen.

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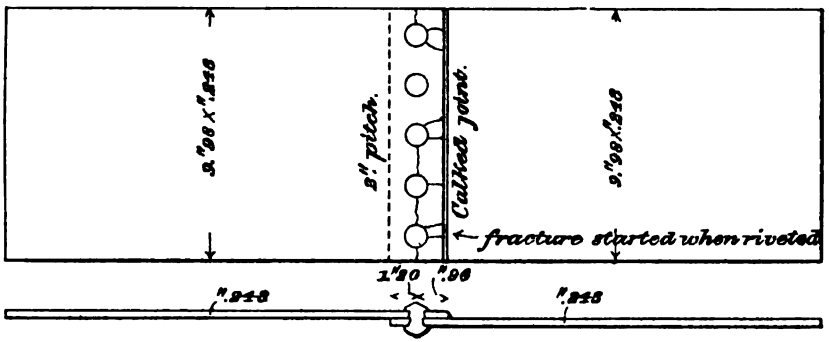
The direction of fracture was diagonally across plate at an angle of 67° 10′ with the axis of the specimen.

When the fractured ends are brought together an opening at the middle remains about ″.23 wide.

SINGLE-RIVETED LAP JOINTS, ¼″ IRON PLATE.

No. 35.—¼″ IRON PLATE. JOINT A.




⅝″ iron rivets, "Burden's best."

Punched holes: Punch, ″.695 diameter; die, ″.752 diameter.

| | Square inches. |
|---|---|
| Gross sectional area of plate | 2.425 |
| Net sectional area of plate | 1.55 |
| Bearing surface of rivets | .78 |
| Shearing area of rivets (″.70 diameter) | 1.92 |

| Loads applied. | Elongation in 10 inches. | Permanent set. | Remarks. |
|---|---|---|---|
| *Pounds.* | *Inch.* | *Inch.* | |
| 5,000 | 0. | | |
| 8,000 | .0009 | | |
| 10,000 | .0012 | | |
| 15,000 | .0018 | | |
| 20,000 | .0040 | | |
| 25,000 | .0059 | | |
| 30,000 | .0080 | | |
| 35,000 | .0108 | | Joint opened about ″.01, or less. |
| 5,000 | | .0030 | Rivet heads scale. |
| 40,000 | .0145 | | |
| 42,000 | .0162 | | |
| 44,000 | .0188 | | |
| 46,000 | .0212 | | |
| 48,000 | .0240 | | |
| 50,000 | .0270 | | Joint opened barely ″.02. |
| 52,000 | .0298 | | |
| 54,000 | .0345 | | |
| 56,000 | .0480 | | |
| 58,000 | .0556 | | |
| 60,000 | .0635 | | |
| 62,000 | .0735 | | |
| 67,000 | | | Ultimate strength. |

Failure occurred by tearing out upper plate at four rivets, as shown by the sketch, and by shearing one rivet, second from outside. The fracture first in sight appeared at the end of the plate at the calked side of the joint. Fractures also appeared at the end of the lap opposite the three middle rivets. In the under plate no fracture apparent at the holes. The sheared rivet had fracture started under the head. Another rivet was slightly fractured in the same manner.

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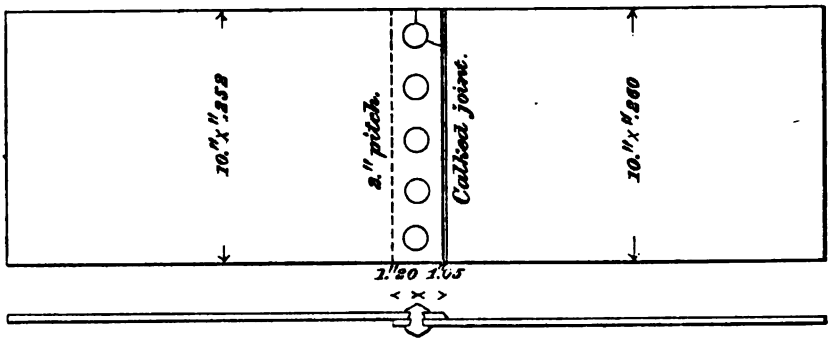
*Maximum loads on joint.*

| | Pounds per sq. inch. |
|---|---|
| Tensile strain on gross section of plate | 27,630 |
| Tensile strain on net section of plate | 43,230 |
| Compressive strain on bearing surface of rivets | 76,140 |
| Shearing strain on rivets | 34,900 |

## No. 36.—$\frac{1}{4}$″ Iron Plate. Joint A . .




$\frac{5}{8}$″ iron rivets, "Burden's best."

Punched holes: Punch, ".695 diameter; die, ".752 diameter.

| | Square inches. |
|---|---|
| Gross sectional area of plate | 2.52 |
| Net sectional area of plate | 1.63 |
| Bearing surface of rivets | .895 |
| Shearing area of rivets (".70 diameter) | 1.92 |

| Loads applied. | Elongation in 10 inches. | Permanent set. | Remarks. |
|---|---|---|---|
| *Pounds.* | *Inch.* | *Inch.* | |
| 5,000 | 0. | | |
| 10,000 | .0009 | | |
| 15,000 | .0018 | | |
| 20,000 | .0028 | | |
| 25,000 | .0040 | | |
| 30,000 | .0058 | | |
| 35,000 | .0078 | | |
| 5,000 | | .0018 | |
| 38,000 | .0088 | | |
| 40,000 | .0103 | | |
| 42,000 | .0117 | | |
| 44,000 | .0130 | | |
| 46,000 | .0148 | | |
| 48,000 | .0103 | | Joint open at calking about ".01. |
| 50,000 | .0198 | | |
| 52,000 | .0253 | | |
| 54,000 | .0308 | | |
| 56,000 | .0378 | | |
| 58,000 | .0458 | | |
| 60,000 | .0537 | | Joint open about ".04 to ".05. |
| 62,000 | .0613 | | |
| 64,000 | .0708 | | |
| 66,000 | .0800 | | |
| 68,000 | .0920 | | |
| 74,200 | | | Ultimate strength. |

Joint failed by shearing four rivets, and tore out upper plate at one end rivet.

Fractures started at end of lap in each plate and opposite each rivet but one.

All the sheared rivets had fractures started under the heads.

Elongation of holes from ".04 to ".08.

Holes with the die-side in, stretching the most.

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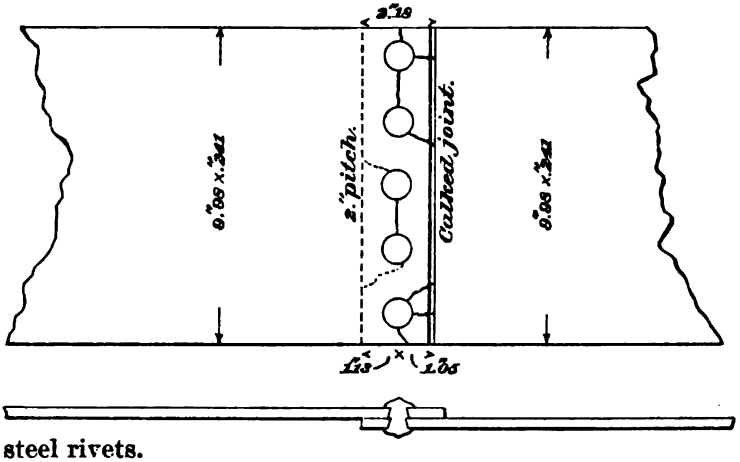
*Maximum loads on joint.*

| | Pounds per sq. inch. |
|---|---|
| Tensile strain on gross section of plate | 29,444 |
| Tensile strain on net section of plate | 45,520 |
| Compressive strain on bearing surface of rivets | 82,910 |
| Shearing strain on rivets | 38,640 |

## No. 41.—¼″ Iron Plate. Joint A A.




⅝″ steel rivets.

Punched holes: Punch, ″.69 diameter; die, ″.75 diameter.

| | Square inch. |
|---|---|
| Gross sectional area of plate | 2.41 |
| Net sectional area of plate | 1.54 |
| Bearing surface of rivets | 0.868 |
| Shearing area of rivets (″.70 diameter) | 1.92 |

| Loads applied. | Elongation in 10 inches. | Permanent set. | Remarks. |
|---|---|---|---|
| *Pounds.* | *Inches.* | *Inches.* | |
| 5,000 | .0 | ..... | |
| 10,000 | .0012 | ..... | |
| 15,000 | .0028 | ..... | |
| 20,000 | .0041 | ..... | |
| 25,000 | .0062 | ..... | |
| 30,000 | .0090 | ..... | |
| 35,000 | .0120 | ..... | |
| 5,000 | ..... | .0040 | |
| 38,000 | .0149 | ..... | |
| 40,000 | .0161 | ..... | Perceptible starting of the joint. |
| 42,000 | .0180 | ..... | Joint open about ″.00½. |
| 44,000 | .0210 | ..... | |
| 46,000 | .0238 | ..... | Joint open ″.01. |
| 48,000 | .0260 | ..... | Joint open ″.02. |
| 50,000 | .0289 | ..... | |
| 52,000 | .0329 | ..... | |
| 54,000 | .0336 | ..... | Joint open about ″.03½. |
| 56,000 | .0400 | ..... | |
| 58,000 | .0438 | ..... | |
| 60,000 | .0480 | ..... | Joint open ″.05. |
| 62,000 | .0528 | ..... | |
| 64,000 | .0589 | ..... | |
| 66,000 | .0650 | ..... | |
| 68,000 | .0790 | ..... | |
| 70,000 | .0860 | ..... | |
| 72,000 | .0970 | ..... | |
| 74,000 | .1080 | ..... | |
| 75,800 | .1240 | ..... | |
| 76,100 | ..... | ..... | Ultimate strength. |

Fractures appeared first at end of upper plate opposite the outside rivets, shown at A. on the sketch.

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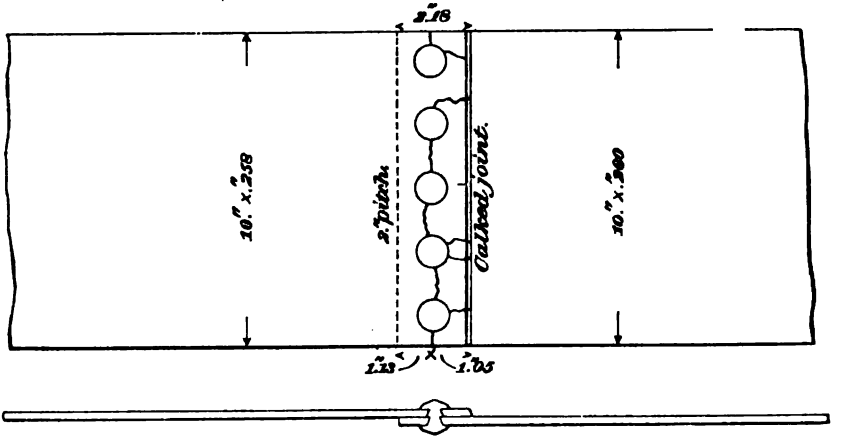
The upper plate tore out behind three rivets; the lower plate at two rivets.

*Maximum loads on joint.*

| | Pounds per sq. inch. |
|---|---|
| Tensile strain on gross section of plate | 31,580 |
| Tensile strain on net section of plate | 49,420 |
| Compressive strain on bearing surface of rivets | 87,670 |
| Shearing strain on rivets | 39,640 |

## No. 42.—¼″ Iron Plate. Joint A A . .




⅝″ steel rivets.

Punched holes: Punch, ″.69 diameter; die, ″.75 diameter.

| | Square inches. |
|---|---|
| Gross sectional area of upper plate | 2.58 |
| Net sectional area of upper plate | 1.65 |
| Bearing surface of rivets | .929 |
| Shearing area of rivets (″.70 diameter) | 1.92 |

| Loads applied. | Elongation in 10 inches. | Permanent set. | Remarks. |
|---|---|---|---|
| *Pounds.* | *Inch.* | *Inch.* | |
| 5,000 | 0. | | |
| 10,000 | .0010 | | |
| 15,000 | .0020 | | |
| 20,000 | .0030 | | |
| 25,000 | .0052 | | |
| 30,000 | .0072 | | |
| 35,000 | .0102 | | |
| 5,000 | | .0045 | |
| 38,000 | .0128 | | |
| 40,000 | .0140 | | Joint started perceptibly. |
| 42,000 | .0159 | | |
| 44,000 | .0180 | | |
| 46,000 | .0210 | | |
| 48,000 | .0238 | | |
| 50,000 | .0260 | | Joint opened ″.01. |
| 52,000 | .0290 | | |
| 54,000 | .0335 | | Joint opened ″.02. |
| 56,000 | .0370 | | Joint opened ″.03. |
| 58,000 | .0420 | | |
| 60,000 | .0468 | | |
| 62,000 | .0530 | | Joint open about ″.04. |
| 64,000 | .0600 | | Joint open about ″.05. |
| 66,000 | .0698 | | Joint open about ″.06. |
| 68,000 | .0780 | | |
| 70,000 | .0870 | | |
| 74,000 | .1085 | | |
| 76,000 | .1215 | | |
| 77,980 | .1410 | | Ultimate strength. |

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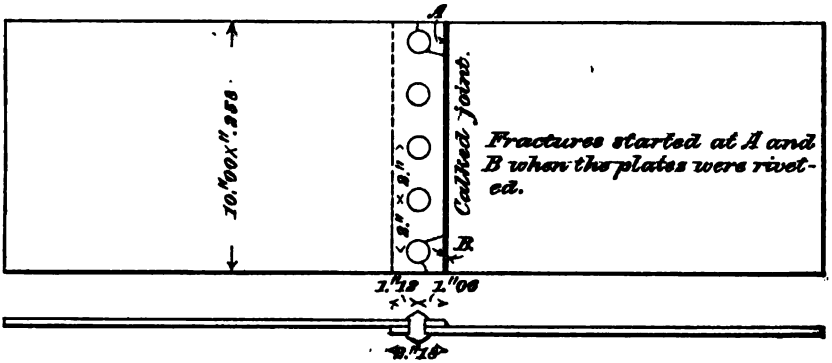
Joint failed by tearing apart upper plate similar to A A., fractures first appearing at end of upper opposite the outside rivets.

The under plate has a slight fracture at end of lap opposite the second rivet.

*Maximum loads on joint.*

| | Pounds per sq. inch. |
|---|---|
| Tensile strain on gross section of upper plate | 30,220 |
| Tensile strain on net section of upper plate | 47,260 |
| Compressive strain on bearing surface of rivets | 83,940 |
| Shearing strain on rivets | 40,610 |

## No. 37.—¼″ Iron Plate. Joint C.




⅝″ iron rivets, "Burden's best."
Drilled holes, ".69 diameter.

| | Square inches. |
|---|---|
| Gross sectional area, upper plate | 2.58 |
| Gross sectional area, lower plate | 2.44 |
| Net sectional area, upper plate | 1.69 |
| Bearing surface of rivets, upper plate | .89 |
| Shearing area of rivets (".69 diameter) | 1.87 |

| Loads applied. | Elongation in 10 inches. | Permanent set. | Remarks. |
|---|---|---|---|
| *Pounds.* | *Inch.* | *Inch.* | |
| 5,000 | 0. | | |
| 10,000 | .0015 | | |
| 15,000 | .0027 | | |
| 20,000 | .0042 | | |
| 25,000 | .0059 | | |
| 30,000 | .0082 | | |
| 35,000 | .0112 | | |
| 5,000 | | .0036 | |
| 38,000 | .0135 | | |
| 40,000 | .0149 | | |
| 42,000 | .0172 | | |
| 44,000 | .0197 | | |
| 46,000 | .0226 | | |
| 48,000 | .0225 | | |
| 50,000 | .0292 | | Calked joint is open about ".02. Scale on rivet heads slightly started. |
| 52,000 | .0322 | | |
| 54,000 | .0429 | | |
| 56,000 | .0527 | | |
| 58,000 | .0632 | | |
| 60,000 | .0749 | | |
| 5,000 | | .0577 | |
| 62,000 | .0885 | | |
| 64,000 | .1305 | | |
| 65,200 | | | Ultimate strength. |

Failed by shearing three inside rivets and tearing out plate at the end rivets of the upper plate.



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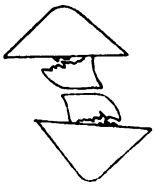
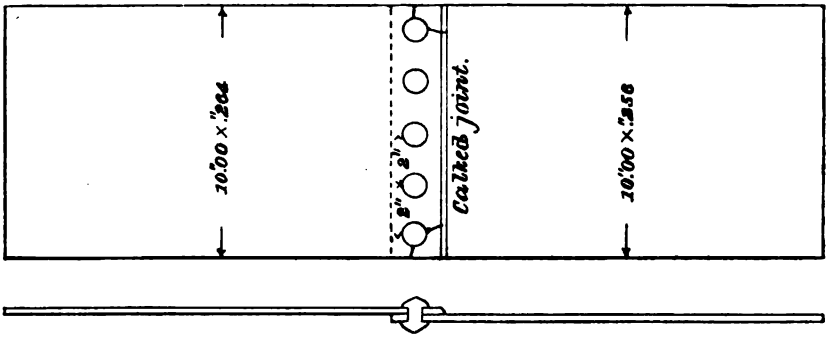
**Rivets that were sheared were also fractured under the head.**



*Maximum loads on joint.*

| | Pounds per sq. inch. |
|---|---|
| Tensile strain on gross section of upper plate | 25,270 |
| Tensile strain on net section of upper plate | 38,580 |
| Compressive strain on bearing surface of rivets | 73,260 |
| Shearing strain on rivets | 34,870 |

## No. 38.—¼″ IRON PLATE. JOINT C . .




⅝″ iron rivets, "Burden's best."
Drilled holes, ″.69 diameter.

| | Square inches. |
|---|---|
| Gross sectional area, upper plate | 2.64 |
| Net sectional area, upper plate | 1.73 |
| Bearing surface of rivets, upper plate | .911 |
| Shearing area of rivets (″.69 diameter) | 1.87 |

| Loads applied. | Elongation in 10 inches. | Permanent set. | Remarks. |
|---|---|---|---|
| *Pounds.* | *Inch.* | *Inch.* | |
| 5,000 | 0. | ..... | |
| 10,000 | .0013 | ..... | |
| 15,000 | .0020 | ..... | |
| 20,000 | .0033 | ..... | |
| 25,000 | .0045 | ..... | |
| 30,000 | .0063 | ..... | |
| 35,000 | .0085 | ..... | |
| 5,000 | ..... | .0023 | |
| 38,000 | .0100 | ..... | |
| 40,000 | .0107 | ..... | |
| 42,000 | .0124 | ..... | Joint opened ″.01, or less. |
| 44,000 | .0137 | ..... | |
| 46,000 | .0163 | ..... | |
| 48,000 | .0184 | ..... | |
| 50,000 | .0210 | ..... | Scale has started on second rivet head. |
| 52,000 | .0235 | ..... | |
| 54,000 | .0270 | ..... | |
| 56,000 | .0317 | ..... | |
| 58,000 | .0445 | ..... | |
| 60,000 | .0517 | ..... | |
| 62,000 | .0605 | ..... | |
| 64,000 | .0705 | ..... | |
| 66,000 | .0815 | ..... | |
| 68,000 | .0957 | ..... | |
| 70,000 | .1135 | ..... | |
| 72,300 | ..... | ..... | Ultimate strength. |

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Fractured in the same manner as C., by shearing the three inside rivets and tearing out the plate at the end rivets.

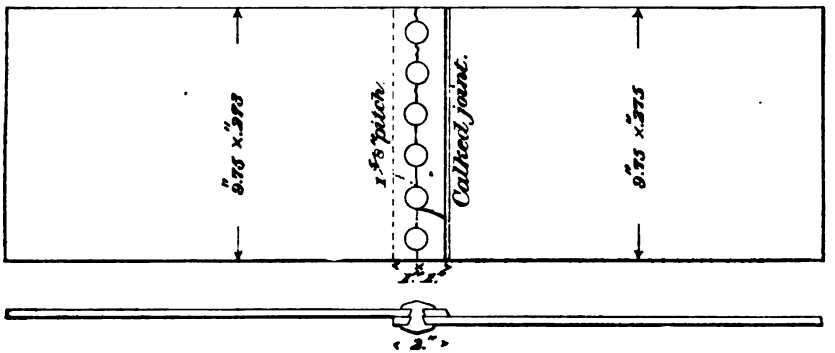
This method of failure would indicate the ability of the plate to shear all the rivets in case the metal at the sides of the specimen was supported and prevented from spreading.

Holes elongated from ".06 to ".08.

*Maximum loads on joint.*

| | Pounds per sq. inch. |
|---|---|
| Tensile strain on gross section of upper plate | 27,380 |
| Tensile strain on net section of upper plate | 41,790 |
| Compressive strain on bearing surface of rivets | 79,360 |
| Shearing strain on rivets | 38,660 |

## No. 39.—¼" Iron Plate. Joint D.




⅝" iron rivets, "Burden's best."

Punched holes: Punch, ".695 diameter; die, ".752 diameter.

| | Square inches. |
|---|---|
| Gross sectional area of plate | 2.66 |
| Net sectional area of plate | 1.48 |
| Bearing surface of rivets | 1.18 |
| Shearing area of rivets (".70 diameter) | 2.31 |

| Loads applied. | Elongation in 10 inches. | Permanent set. | Remarks. |
|---|---|---|---|
| *Pounds.* | *Inch.* | *Inch.* | |
| 5,000 | 0. | | |
| 10,000 | .0010 | | |
| 15,000 | .0021 | | |
| 20,000 | .0036 | | |
| 25,000 | .0051 | | |
| 30,000 | .0071 | | |
| 35,000 | .0101 | | |
| 5,000 | | .0029 | |
| 38,000 | .0117 | | |
| 40,000 | .0132 | | |
| 42,000 | .0151 | | |
| 44,000 | .0171 | | |
| 46,000 | .0193 | | |
| 48,000 | .0223 | | |
| 50,000 | .0251 | | |
| 52,000 | .0298 | | |
| 54,000 | .0331 | | |
| 56,000 | .0373 | | |
| 58,000 | .0422 | | |
| 60,000 | .0501 | | |
| 62,000 | .0571 | | |
| 64,000 | .0651 | | |
| 66,000 | .0760 | | |
| 68,000 | .0830 | | |
| 70,000 | 0960 | | |
| 72,000 | .1060 | | |
| 77,200 | | | Ultimate strength. |

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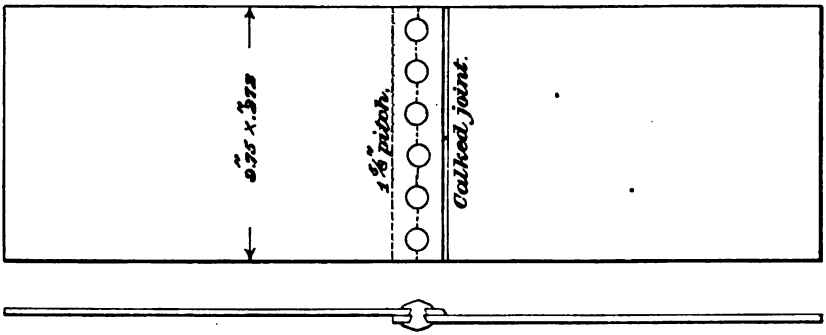
Joint failed by fracturing the upper plate across five sections and the under plate across two sections of the plate between rivet holes.

*Maximum loads on joint.*

| | Pounds per sq. inch. |
|---|---|
| Tensile strain on gross section of plate | 29,020 |
| Tensile strain on net section of plate | 52,160 |
| Compressive strain on bearing surface of rivets | 65,420 |
| Shearing strain on rivets | 33,420 |

## No. 40.—¼″ Iron Plate. Joint D . .




⅝″ iron rivets, "Burden's best."
Punched holes: Punch, ".695 diameter; die, ".752 diameter.

| | Square inches. |
|---|---|
| Gross sectional area of plate | 2.65 |
| Net sectional area of plate | 1.48 |
| Bearing surface of rivets | 1.18 |
| Shearing area of rivets | 2.31 |

| Loads applied. | Elongation in 10 inches. | Permanent set. | Remarks. |
|---|---|---|---|
| *Pounds.* | *Inch.* | *Inch.* | |
| 5,000 | 0. | ..... | |
| 10,000 | .0007 | ..... | |
| 15,000 | .0020 | ..... | |
| 20,000 | .0032 | ..... | |
| 25,000 | .0050 | ..... | |
| 30,000 | .0070 | ..... | |
| 35,000 | .0094 | ..... | |
| 5,000 | ..... | .0032 | |
| 38,000 | .0114 | ..... | |
| 40,000 | .0132 | ..... | |
| 42,000 | .0150 | ..... | |
| 44,000 | .0167 | ..... | |
| 46,000 | .0192 | ..... | |
| 48,000 | .0217 | ..... | |
| 50,000 | .0252 | ..... | |
| 52,000 | .0292 | ..... | |
| 54,000 | .0322 | ..... | |
| 56,000 | .0358 | ..... | |
| 58,000 | .0397 | ..... | |
| 60,000 | .0462 | ..... | |
| 62,000 | .0510 | ..... | |
| 64,000 | .0572 | ..... | |
| 66,000 | .0640 | ..... | |
| 68,000 | .0714 | ..... | Joint about ".05 open. |
| 70,000 | .0807 | ..... | |
| 72,000 | .0912 | ..... | |
| 74,000 | .1000 | ..... | |
| 81,300 | ..... | ..... | Ultimate strength. |

Joint failed by fracturing the lower plate square across through line of rivet holes.

Fractures started slightly at end of plate opposite two rivets.

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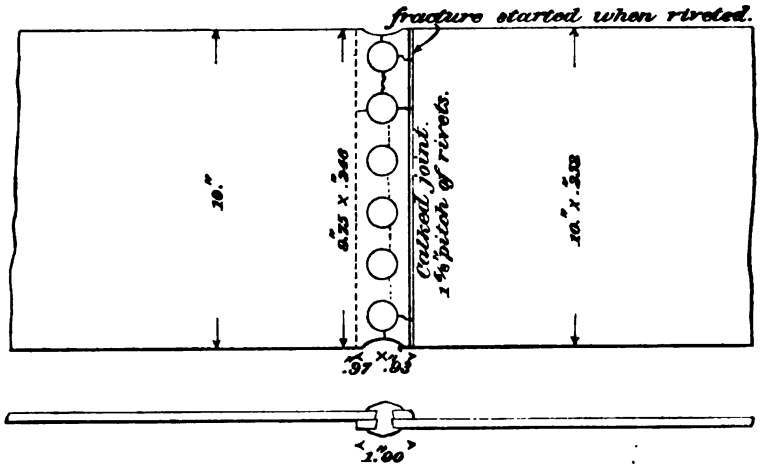
*Maximum loads on joint.*

| | Pounds. per sq. inch. |
|---|---|
| Tensile strain on gross section of plate | 30,680 |
| Tensile strain on net section of plate | 54,930 |
| Compressive strain on bearing surface of rivets | 68,890 |
| Shearing strain on rivets | 35,200 |

## No. 43.—¼″ Iron Plate. Joint D D.




¼″ tool steel rivets.
Punched holes: Punch, ″.568 diameter; die, ″.636 diameter.

| | Square inches. |
|---|---|
| Gross sectional area of upper plate | 2.40 |
| Net sectional area of upper plate | 1.51 |
| Bearing surface of rivets | .886 |
| Shearing area of rivets (″.57 diameter) | 1.53 |

| Loads applied. | Elongation in 10 inches. | Permanent set. | Remarks. |
|---|---|---|---|
| *Pounds.* | *Inch.* | *Inch.* | |
| 5,000 | 0. | | |
| 10,000 | .0007 | | |
| 15,000 | .0016 | | |
| 20,000 | .0033 | | |
| 25,000 | .0045 | | |
| 30,000 | .0070 | | |
| 35,000 | .0100 | | |
| 5,000 | | .0035 | |
| 38,000 | .0125 | | |
| 40,000 | .0136 | | Joint started perceptibly. |
| 42,000 | .0160 | | |
| 44,000 | .0185 | | |
| 46,000 | .0205 | | Joint open nearly ″.01. |
| 48,000 | .0245 | | |
| 50,000 | .0280 | | |
| 5,000 | | .0165 | |
| 52,000 | .0325 | | Joint open ″.02. |
| 54,000 | .0375 | | |
| 56,000 | .0435 | | Joint open ″.03. |
| 58,000 | .0515 | | |
| 60,000 | .0637 | | Joint open ″.04. |
| 62,000 | .0735 | | |
| 64,000 | .0873 | | Joint open ″.06. |
| 66,000 | .1040 | | |
| 68,000 | .1250 | | |
| 69,300 | .1555 | | Ultimate strength. |

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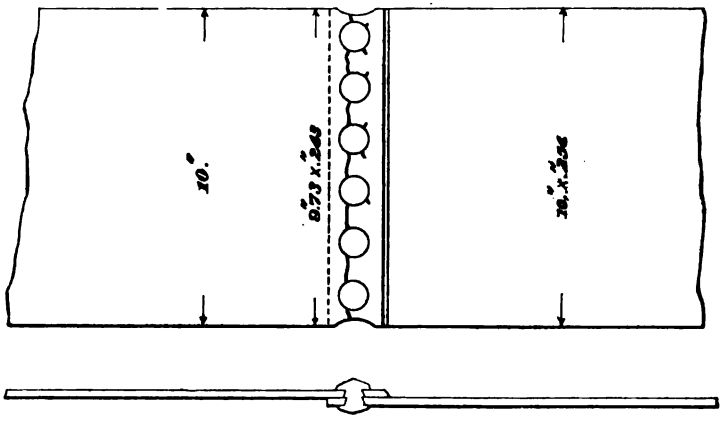
Joint failed by tearing out at two rivets in upper plate and through line of four rivets in under plate. The initial fracture caused by riveting was apparent by a source of weakness. Failure in the under plate appeared wholly due to fractures starting at the rivet holes and tearing till they met. In every case except one, fractures were started at the rivet holes; an examination of the fractured plates would indicate that the failure was due to the excessive compressive strain on the holes, and that by concentrating the strain on $\frac{1}{2}''$ rivets a smaller percentage of the full strength of the plate is obtained than by using $\frac{5}{8}''$ rivets, as was done in experiments D. and D.. It is observed that the fracture in the under plate did not follow a line through the center of the holes, but along a parallel line inside or on the side of the center line opposite the lap end.

The same remarks apply to the position of the fractures started about the rivet holes.

*Maximum loads on joint.*

| | Pounds per sq. inch. |
|---|---|
| Tensile strain on gross section of upper plate | 28,875 |
| Tensile strain on net section of upper plate | 45,890 |
| Compressive strain on bearing surface of rivets | 78,220 |
| Shearing strain on rivets | 45,300 |

No. 44.—$\frac{1}{4}''$ IRON PLATE. JOINT D D..




$\frac{1}{2}''$ tool steel rivets.
Punched holes: Punch, ".568 diameter; die, ".636 diameter.

| | Square inches. |
|---|---|
| Gross sectional area of upper plate | 2.36 |
| Net sectional area of upper plate | 1.49 |
| Bearing surface of rivets | .875 |
| Shearing area of rivets (".57 diameter) | 1.53 |

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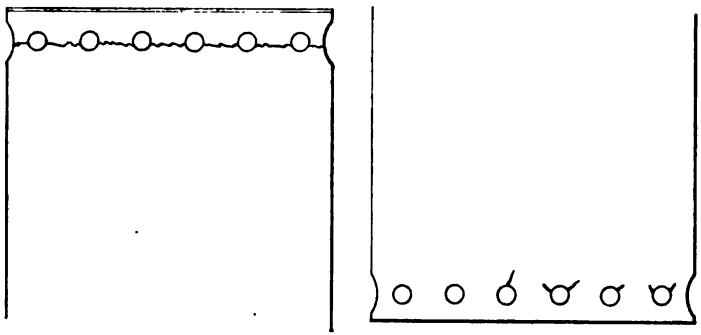
| Loads applied. | Elongation in 10 inches. | Permanent set. | Remarks. |
|---|---|---|---|
| *Pounds.* | *Inch.* | *Inch.* | |
| 5,000 | 0. | ..... | |
| 10,000 | .0011 | ..... | |
| 15,000 | .0022 | ..... | |
| 20,000 | .0038 | ..... | |
| 25,000 | .0055 | ..... | |
| 30,000 | .0079 | ..... | |
| 35,000 | .0110 | ..... | |
| 5,000 | ..... | .0045 | |
| 38,000 | .0130 | ..... | |
| 40,000 | .0148 | ..... | Perceptible movement in joint. |
| 42,000 | .0165 | ..... | |
| 44,000 | .0185 | ..... | |
| 46,000 | .0209 | ..... | Joint open ".01. |
| 48,000 | .0240 | ..... | |
| 50,000 | .0275 | ..... | Joint open ".02. |
| 52,000 | .0312 | ..... | |
| 54,000 | .0360 | ..... | Joint open ".03. |
| 56,000 | .0408 | ..... | |
| 58,000 | .0455 | ..... | Joint open ".04. |
| 60,000 | .0525 | ..... | |
| 62,000 | .0590 | ..... | Joint open ".05. |
| 64,000 | .0678 | ..... | |
| 66,000 | .0758 | ..... | |
| 68,000 | .0832 | ..... | |
| 70,000 | .0942 | ..... | |
| 72,000 | .1070 | ..... | |
| 74,000 | .1250 | ..... | |
| 74,080 | .1278 | ..... | Ultimate strength. |

Fractured square across upper plate, along a line inside of the center line of rivet holes.

Fracture started about holes in lower plate, as shown by the following sketch:



The difference in strength, 4,780 pounds between D D . and D D . . is attributed to the weakening of joint D D . by the riveting at the end section which burst the plate at that place.

*Maximum loads on joint.*

| | Pounds per sq. inch. |
|---|---|
| Tensile strain on gross section of upper plate | 31,390 |
| Tensile strain on net section of upper plate | 49,720 |
| Compressive strain on bearing surface of rivets | 84,660 |
| Shearing strain on rivets | 48,420 |

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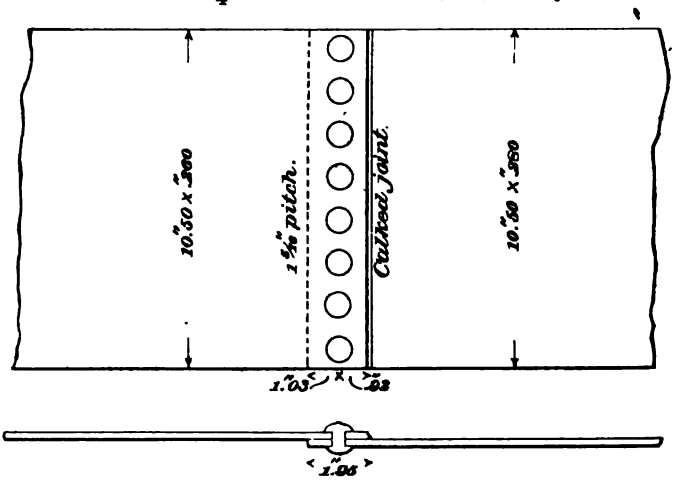
## No. 45.—¼" IRON PLATE. JOINT H.




Eight $\frac{7}{16}$" iron rivets, "Burden's best."
Drilled holes, ".50 diameter.

| | Square inches. |
|---|---|
| Gross sectional area of upper plate | 2.73 |
| Net sectional area of upper plate | 1.69 |
| Bearing surface of rivets | 1.04 |
| Shearing area of rivets | 1.57 |

| Loads applied. | Elongation in 10 inches. | Permanent set. | Remarks. |
|---|---|---|---|
| *Pounds.* | *Inch.* | *Inch.* | |
| 5,000 | 0. | | |
| 10,000 | .0008 | | |
| 15,000 | .0018 | | |
| 20,000 | .0030 | | |
| 25,000 | .0050 | | |
| 30,000 | .0090 | | |
| 35,000 | .0130 | | |
| 5,000 | | .0068 | |
| 38,000 | .0158 | | Joint started perceptibly; slight scaling of rivet heads. |
| 40,000 | .0180 | | |
| 42,000 | .0200 | | Joint open ".01. |
| 44,000 | .0235 | | |
| 46,000 | .0268 | | |
| 48,000 | .0305 | | Joint open ".02. |
| 50,000 | .0368 | | |
| 52,000 | .0420 | | Joint open ".03. |
| 54,000 | .0490 | | |
| 56,000 | .0560 | | |
| 58,000 | .0670 | | Joint open ".05. |
| 60,000 | .0758 | | Joint open ".06. |
| 62,000 | .0848 | | |
| 63,000 | .0928 | | Slight snapping sound. |
| 69,450 | | | Ultimate strength. Sheared the rivets. |

Average elongation of rivet holes, ".07.
Fractures started in the outside sections of the plate.

*Maximum loads on joint.*

| | Pounds per sq. inch. |
|---|---|
| Tensile strain on gross section of plate | 25,440 |
| Tensile strain on net section of plate | 41,095 |
| Compressive strain on bearing surface of rivets | 66,778 |
| Shearing strain on rivets | 44,204 |

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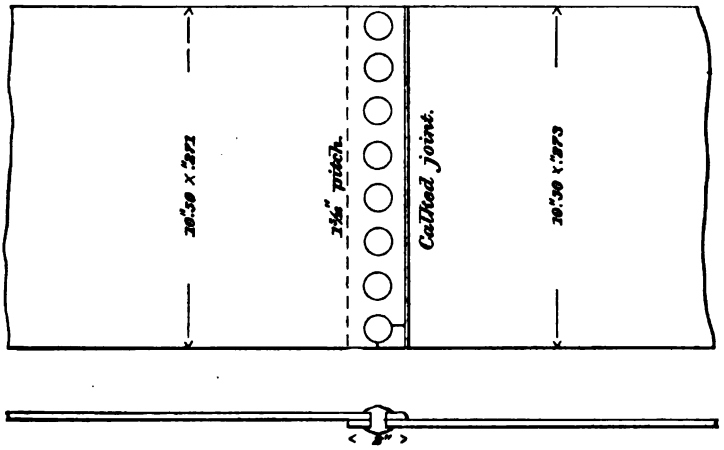
## No. 46.—1/4" IRON PLATE. JOINT H..




Eight 7/16" iron rivets, "Burden's best."
Drilled holes, 1/2" diameter.

| | Square inches. |
|---|---|
| Gross sectional area of upper plate | 2.85 |
| Net sectional area of upper plate | 1.76 |
| Bearing surface of rivets | 1.084 |
| Shearing area of rivets | 1.57 |

| Loads applied. | Elongation in 10 inches. | Permanent set. | Remarks. |
|---|---|---|---|
| *Pounds.* | *Inch.* | *Inch.* | |
| 5,000 | 0. | | |
| 10,000 | .0005 | | |
| 15,000 | .0008 | | |
| 20,000 | .0018 | | |
| 25,000 | .0040 | | |
| 30,000 | .0070 | | |
| 35,000 | .0120 | | Scale starts on rivet heads. |
| 5,000 | | .0072 | |
| 38,000 | .0160 | | Joint started perceptibly. |
| 40,000 | .0178 | | |
| 42,000 | .0200 | | |
| 44,000 | .0235 | | |
| 46,000 | .0270 | | Joint open ".01. |
| 48,000 | .0335 | | |
| 50,000 | .0398 | | Joint open ".02. |
| 5,000 | | .0290 | |
| 52,000 | .0470 | | Joint open ".03. |
| 54,000 | .0572 | | Joint open ".04. |
| 56,000 | .0665 | | |
| 58,000 | .0770 | | Joint open ".07. |
| 60,000 | .0908 | | |
| 62,000 | .1070 | | |
| 64,000 | .1260 | | |
| 66,000 | .1500 | | Ultimate strength. Sheared seven rivets, tore out plate at one end rivet. |

Fractures started about rivet holes.
Average elongation of holes ".09 in plate not fractured.

*Maximum loads on joint.*

| | Pounds per sq. inch. |
|---|---|
| Tensile strain on gross section of plate | 23,158 |
| Tensile strain on net section of plate | 37,500 |
| Compressive strain on bearing surface of rivets | 60,886 |
| Shearing strain on rivets | 42,038 |

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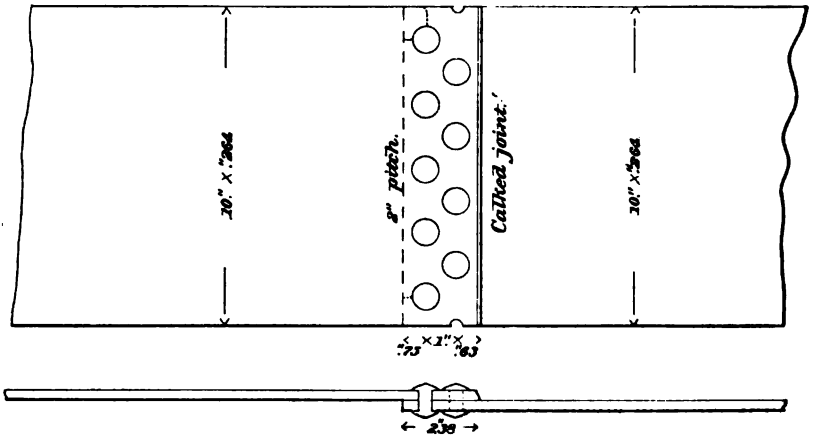
## DOUBLE RIVETED LAP JOINTS ¼″ IRON PLATE.

### No. 85.—¼″ IRON PLATE. JOINT I.




7/16″ iron rivets, "Burden's best."
Drilled holes, ″.50 diameter.

| | Square inches. |
|---|---|
| Gross sectional area of plate | 2.64 |
| Net sectional area of plate | 1.98 |
| Bearing surface of rivets | 1.19 |
| Shearing area of rivets | 1.77 |

| Loads applied. | Elongation in 10 inches. | Permanent set. | Remarks. |
|---|---|---|---|
| *Pounds.* | *Inch.* | *Inch.* | |
| 5,000 | 0. | | |
| 10,000 | .0009 | | |
| 20,000 | .0030 | | |
| 30,000 | .0065 | | |
| 40,000 | .0128 | | |
| 45,000 | .0168 | | |
| 50,000 | .0212 | | |
| 55,000 | .0362 | | Joint opened perceptibly. |
| 60,000 | .0438 | | Joint opened ″.01. |
| 5,000 | | .0315 | Joint does not close. |
| 65,000 | .0600 | | Joint open ″.03. |
| 70,000 | .0802 | | Joint open ″.04. |
| 72,000 | .0950 | | Joint open ″.06. |
| 74,000 | .1180 | | |
| 76,300 | | | Ultimate strength. Sheared eight rivets tore out plate at one end rivet, started fracture in plate at other end rivet. |

Average elongation of holes, ″.06.

*Maximum loads on joint.*

| | Pounds per sq. inch. |
|---|---|
| Tensile strain on gross area of plate | 28,900 |
| Tensile strain on net area of plate | 38,535 |
| Compressive strain on bearing surface of rivets | 64,120 |
| Shearing strain on rivets | 43,110 |

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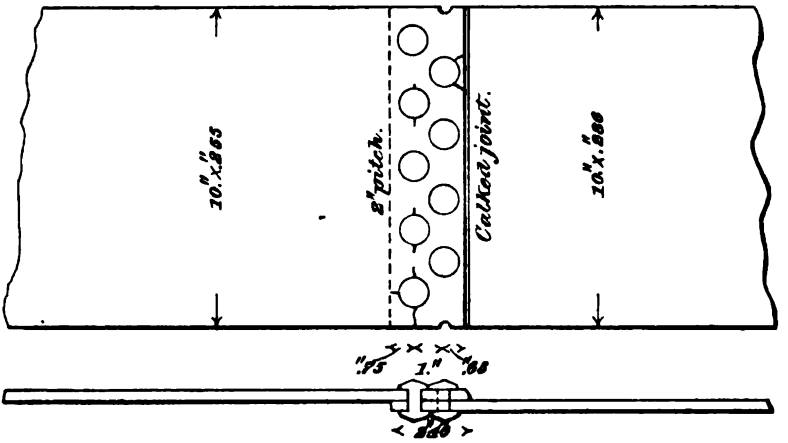
## No. 86.—$\frac{1}{4}$" Iron Plate. Joint I . .




$\frac{7}{16}$" iron rivets, "Burden's best."
Drilled holes, ".50 diameter.

| | Square inches. |
|---|---|
| Gross sectional area of under plate | 2.36 |
| Net sectional area of under plate | 1.77 |
| Bearing surface of rivets | 1.06 |
| Shearing area of rivets | 1.77 |

| Loads applied. | Elongation in 10 inches. | Permanent set. | Remarks. |
|---|---|---|---|
| *Pounds.* | *Inch.* | *Inch.* | |
| 5,000 | 0. | | |
| 10,000 | .0008 | | |
| 20,000 | .0025 | | |
| 30,000 | .0060 | | |
| 35,000 | .0098 | | |
| 40,000 | .0130 | | |
| 45,000 | .0170 | | |
| 50,000 | .0220 | | Joint opened perceptibly. |
| 5,000 | | .0125 | |
| 55,000 | .0335 | | Joint open ".01. |
| 60,000 | .0508 | | |
| 65,000 | | | |
| 73,900 | | | Ultimate strength. Sheared seven rivets, tore out plate at two rivets. |

Fractures started about holes in upper plate in the row of five holes.

*Maximum loads on joint.*

| | Pounds per sq. inch. |
|---|---|
| Tensile strain on gross section of under plate | 31,314 |
| Tensile strain on net section of under plate | 41,750 |
| Compressive strain on bearing surface of rivets | 69,710 |
| Shearing strain on rivets | 41,750 |

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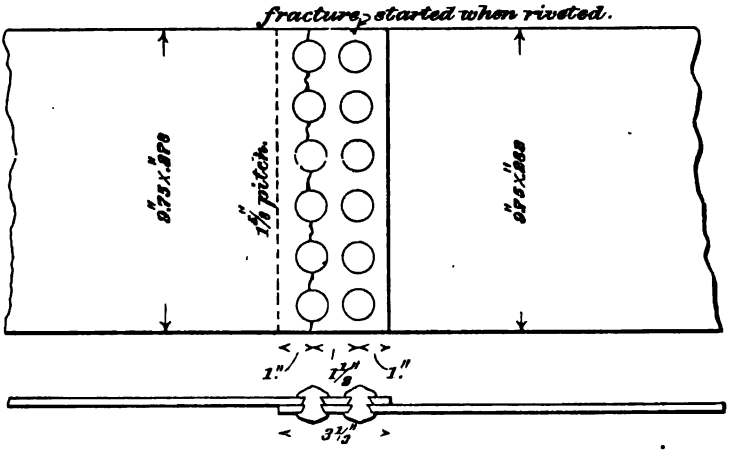
## No. 617.—¼″ Wrought Iron Plate. Plates K.




½″ iron rivets, "Burden's best."
Punched holes: Punch, $\frac{9}{16}$″ diameter; die, $\frac{11}{32}$″ diameter.

| | Square inches. |
|---|---|
| Gross sectional area of upper plate | 2.71 |
| Net sectional area of upper plate | 1.69 |
| Bearing surface of rivets | 2.03 |
| Shearing area of rivets | 2.98 |

| Loads applied. | Elongation in 10 inches. | Permanent set. | Remarks. |
|---|---|---|---|
| *Pounds.* | *Inch.* | *Inch.* | |
| 5,000 | 0. | | |
| 10,000 | .0040 | | Plates not straight; marked in riveting. |
| 20,000 | .0145 | | |
| 30,000 | .0220 | | Elongations include the straightening of the metal. |
| 35,000 | .0260 | | |
| 5,000 | | .0150 | |
| 40,000 | .0300 | | |
| 50,000 | .0410 | | |
| 60,000 | .0500 | | |
| 73,300 | .0900 | | |
| 76,900 | .12 | | |
| 85,500 | .22 | | Ultimate strength. |

Fractured upper plate across row of rivet holes. Started fractures in upper plate at end of lap.

*Maximum loads on joint.*

| | Pounds per sq. inch. |
|---|---|
| Tensile strain on gross section of upper plate | 31,550 |
| Tensile strain on net section of upper plate | 50,592 |
| Compressive strain on bearing surface of rivets | 42,118 |
| Shearing strain on rivets | 28,691 |

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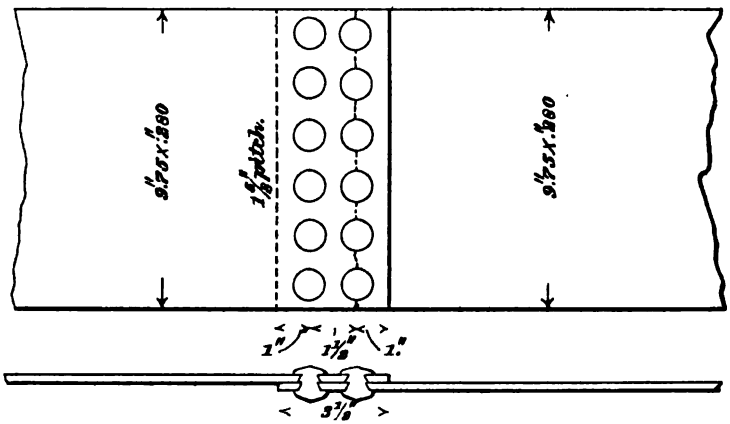
## No. 618.—¼″ Iron Plate. Plates K . .

### Duplicate of K .




½″ iron rivets, "Burden's best."
Punched holes: Punch, $\frac{9}{16}$″ diameter; die, $\frac{11}{32}$″ diameter.

| | Square inches. |
|---|---|
| Gross sectional area of under plate | 2.73 |
| Net sectional area of under plate | 1.71 |
| Bearing surface of rivets | 2.05 |
| Shearing area of rivets | 2.98 |

| Loads applied. | Elongation in 10 inches. | Permanent set. | Remarks. |
|---|---|---|---|
| *Pounds.* | *Inch.* | *Inch.* | |
| 5,000 | 0. | ..... | |
| 10,000 | .0009 | ..... | |
| 20,000 | .0030 | ..... | |
| 30,000 | .0065 | ..... | |
| 35,000 | .0088 | ..... | |
| 5,000 | ..... | .0020 | |
| 40,000 | .0110 | ..... | |
| 45,000 | .0145 | ..... | |
| 50,000 | .0190 | ..... | |
| 5,000 | ..... | .0095 | |
| 55,000 | .0228 | ..... | |
| 60,000 | .0280 | ..... | |
| 65,000 | .0350 | ..... | |
| 70,000 | .06 | ..... | |
| 75,000 | .10 | ..... | |
| 80,000 | .14 | ..... | |
| 85,000 | .19 | ..... | |
| 85,400 | ..... | ..... | Ultimate strength. |

Fractured under plate across line of rivet holes.

*Maximum loads on joint.*

| | Pounds per sq. inch. |
|---|---|
| Tensile strain on gross section of under plate | 31,282 |
| Tensile strain on net section of under plate | 49,950 |
| Compressive strain on bearing surface of rivets | 41,660 |
| Shearing strain on rivets | 28,660 |

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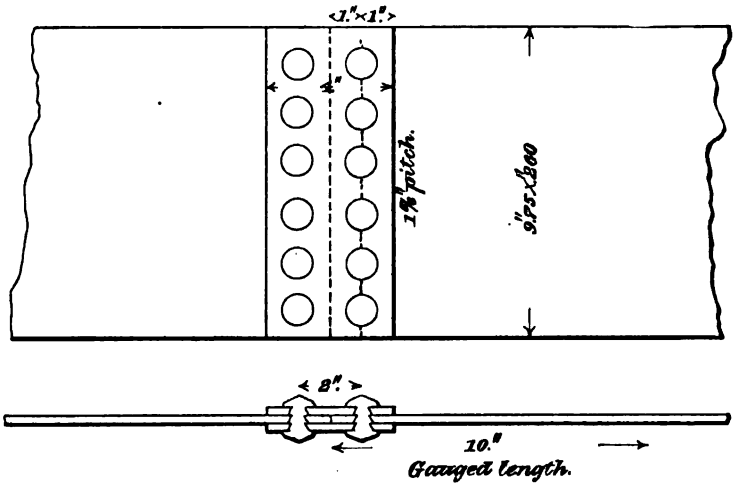
SINGLE-RIVETED BUTT JOINTS, ¼″ IRON PLATE.

## No. 615.—¼″ Iron Plate Butt Joints. Plates L.




⅝″ iron rivets, "Burden's best."
Punched holes: Punch, 1 1/16″ diameter; die, ¾″ diameter.

| | Square inches |
|---|---|
| Gross sectional area of plate | 2.53 |
| Net sectional area of plate | 1.41 |
| Bearing surface of rivets | 1.12 |
| Shearing area of rivets | 4.45 |

| Loads applied. | Elongation in 10 inches. | Permanent set. | Remarks. |
|---|---|---|---|
| *Pounds.* | *Inch.* | *Inch.* | |
| 10,000 | 0. | ..... | |
| 15,000 | .0010 | ..... | |
| 20,000 | .0021 | ..... | |
| 25,000 | .0035 | ..... | |
| 30,000 | .0045 | ..... | |
| 35,000 | .0055 | ..... | |
| 10,000 | ..... | .0002 | |
| 40,000 | .0075 | ..... | |
| 45,000 | .0110 | ..... | |
| 50,000 | .0130 | ..... | |
| 55,000 | .0160 | ..... | |
| 60,000 | .0190 | ..... | |
| 10,000 | ..... | .0110 | |
| 70,000 | .10 | ..... | |
| 75,000 | .15 | ..... | |
| 75,400 | ..... | ..... | Ultimate strength. |

Fractured plate across line of rivet holes.

*Maximum loads on joint.*

| | Pounds per sq. inch. |
|---|---|
| Tensile strain on gross sectional area of plate | 29,800 |
| Tensile strain on net sectional area of plate | 53,475 |
| Compressive strain on bearing surface of rivets | 67,321 |
| Shearing strain on rivets | 16,944 |

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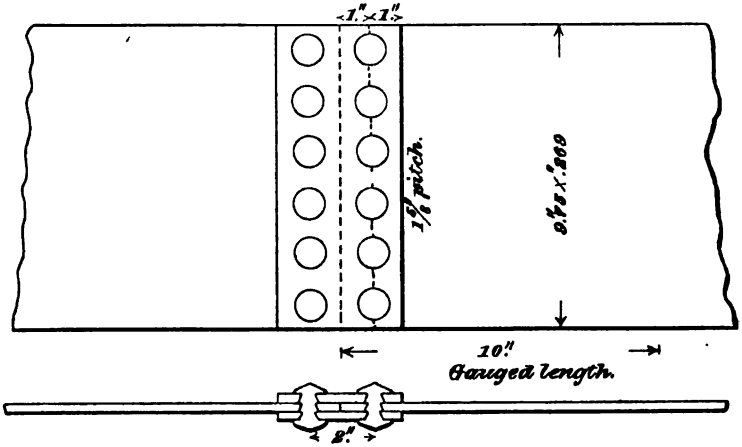
## No. 616.—¼″ Iron Plate Butt Joint. Plates L . .

### Duplicate of L .




⅝″ iron rivets, "Burden's best."
Punched holes: Punch, $\frac{11}{16}$″ diameter; die, ¾″ diameter.

| | Square inches. |
|---|---|
| Gross sectional area of plate | 2.62 |
| Net sectional area of plate | 1.46 |
| Bearing surface of rivets | 1.16 |
| Shearing area of rivets | 4.45 |

| Loads applied. | Elongation in 10 inches. | Permanent set. | Remarks. |
|---|---|---|---|
| *Pounds.* | *Inch.* | *Inch.* | |
| 5,000 | 0. | ..... | |
| 10,000 | .0010 | ..... | |
| 20,000 | .0028 | ..... | |
| 30,000 | .0050 | ..... | |
| 35,000 | .0060 | ..... | |
| 5,000 | ..... | .0009 | |
| 40,000 | .0070 | ..... | |
| 42,000 | .0075 | ..... | |
| 44,000 | .0080 | ..... | |
| 46,000 | .0085 | ..... | |
| 48,000 | .0090 | ..... | |
| 50,000 | .0098 | ..... | |
| 52,000 | .0105 | ..... | |
| 54,000 | .0111 | ..... | |
| 56,000 | .0121 | ..... | |
| 58,000 | .0132 | ..... | |
| 60,000 | .0150 | ..... | |
| 62,000 | .0168 | ..... | |
| 64,000 | .0180 | ..... | |
| 66,000 | .0200 | ..... | |
| 68,000 | .0255 | ..... | |
| 70,900 | *.06 | ..... | |
| 74,400 | .14 | ..... | Ultimate strength. |

* About ".06.

### Fractured plate across line of rivet holes.

*Maximum loads on joint.*

| | Pounds per sq. inch. |
|---|---|
| Tensile strain on gross section of plate | 28,397 |
| Tensile strain on net section of plate | 50,959 |
| Compressive strain on bearing surface of rivets | 64,138 |
| Shearing strain on rivets | 16,719 |

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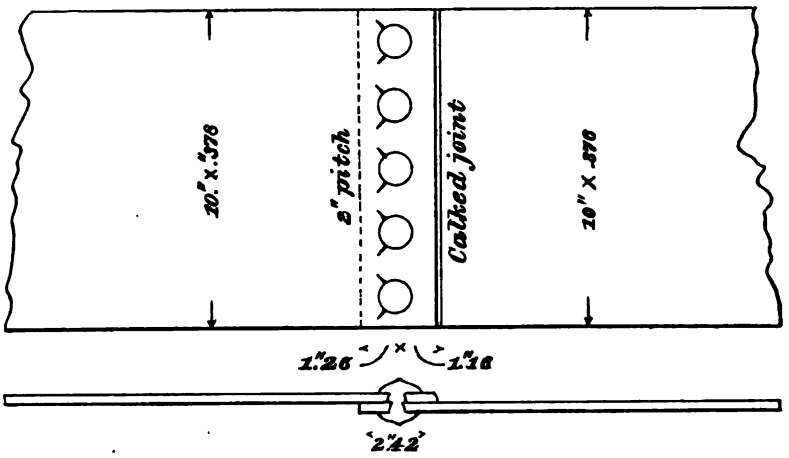
SINGLE-RIVETED LAP JOINTS ¾″ IRON PLATE.

## No. 62.—⅜″ Iron Plates. Joint A.




$\frac{11}{16}$″ iron rivets, "Burden's best."
Punched holes: Punch, ".753 diameter; die, ".774 diameter.

| | Square inches. |
|---|---|
| Gross sectional area of plate | 3.76 |
| Net sectional area of plate | 2.32 |
| Bearing surface of rivets | 1.44 |
| Shearing area of rivets (.″76 diameter) | 2.27 |

| Loads applied. | Elongation in 10 inches. | Permanent set. | Remarks. |
|---|---|---|---|
| *Pounds.* | *Inch.* | *Inch.* | |
| 5,000 | 0. | ..... | |
| 10,000 | .0005 | ..... | |
| 20,000 | .0018 | ..... | |
| 30,000 | .0048 | ..... | |
| 35,000 | .0070 | ..... | |
| 5,000 | ..... | .0040 | |
| 40,000 | .0100 | ..... | Joint started slightly. |
| 42,000 | .0112 | ..... | |
| 44,000 | .0128 | ..... | |
| 46,000 | .0145 | ..... | |
| 48,000 | .0160 | ..... | |
| 50,000 | .0192 | ..... | Joint open ".01. Scale starts on rivet heads about the same time the joint begins to open. |
| 52,000 | .0220 | ..... | |
| 54,000 | .0248 | ..... | |
| 56,000 | .0280 | ..... | |
| 58,000 | .0320 | ..... | |
| 60,000 | .0395 | ..... | Joint open ".02. |
| 62,000 | .0458 | ..... | Joint open ".03. |
| 64,000 | .0525 | ..... | |
| 66,000 | .0588 | ..... | Joint open ".04. |
| 68,000 | .0660 | ..... | Joint open ".05. |
| 70,000 | .0740 | ..... | |
| 72,000 | .0838 | ..... | |
| 74,000 | .0938 | ..... | |
| 80,000 | .1320 | ..... | |
| 85,000 | .1810 | ..... | |
| 86,900 | ..... | ..... | Ultimate strength. Sheared rivets. |

Started fractures about rivet holes inside of center line of holes.
Average elongation of holes, ".04.

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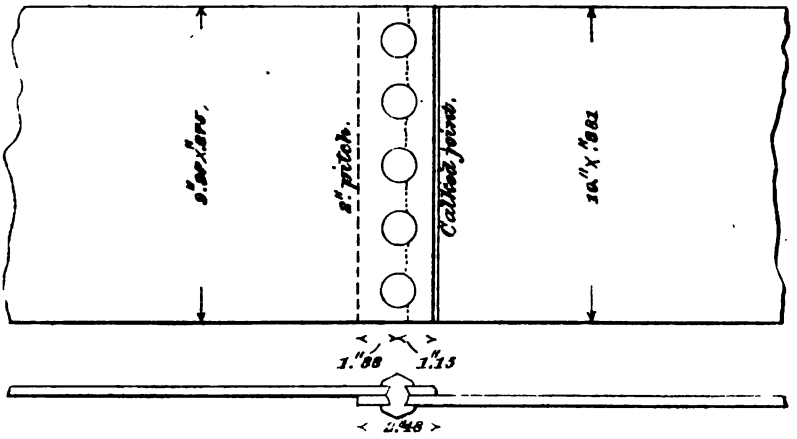
*Maximum loads on joint.*

| | Pounds per sq. inch. |
|---|---|
| Tensile strain on gross section of plate | 23,110 |
| Tensile strain on net section of plate | 37,460 |
| Compressive strain on bearing surface of rivets | 60,340 |
| Shearing strain on rivets | 38,280 |

## No. 63.—⅜″ Iron Plate. Joint A . .




$\frac{11}{16}$″ iron rivets, "Burden's best."
Punched holes: Punch, ".753 diameter; die, ".774 diameter.

| | Square inches. |
|---|---|
| Gross sectional area of plate | 3.81 |
| Net sectional area of plate | 2.35 |
| Bearing surface of rivets | 1.46 |
| Shearing area of rivets (".78 diameter) | 2.39 |

| Loads applied. | Elongation in 10 inches. | Permanent set. | Remarks. |
|---|---|---|---|
| *Pounds.* | *Inch.* | *Inch.* | |
| 5,000 | 0. | | |
| 10,000 | .0005 | | |
| 20,000 | .0012 | | |
| 30,000 | .0039 | | |
| 35,000 | .0065 | | |
| 5,000 | | .0032 | |
| 40,000 | .0090 | | |
| 45,000 | .0121 | | |
| 50,000 | .0170 | | Joint opened perceptibly. |
| 55,000 | .0240 | | Joint opened ".01. |
| 60,000 | .0389 | | |
| 65,000 | .0560 | | Joint opened ".02. |
| 70,000 | .0770 | | Joint opened ".04. |
| 75,000 | .1040 | | |
| 80,000 | .1400 | | |
| 84,900 | | | Ultimate strength. Fractured the under plate. |

Fractures dull fibrous. Fractures started about the rivet holes in the upper plate.

*Maximum loads on joint.*

| | Pounds per sq. inch. |
|---|---|
| Tensile strain on gross section of plate | 22,280 |
| Tensile strain on net section of plate | 36,130 |
| Compressive strain on bearing surface of rivets | 58,150 |
| Shearing strain on rivets | 35,520 |



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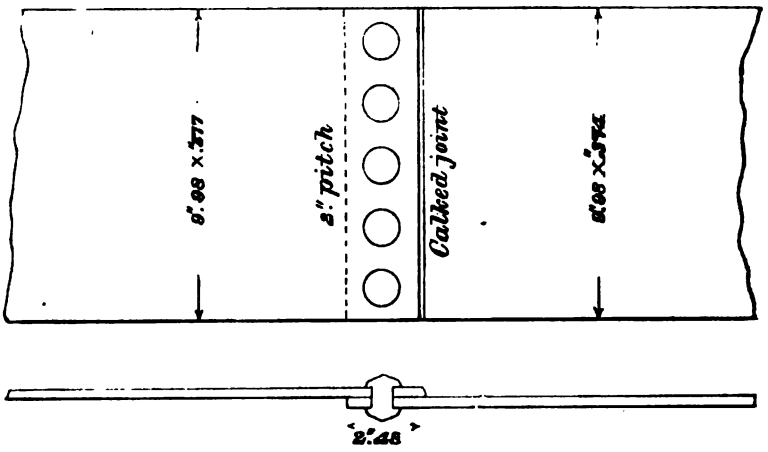
## No. 64.—⅜" Iron Plate. Joint C.




1⅛" iron rivets, "Burden's best."
Drilled holes, ".77 diameter.

| | Square inches. |
|---|---|
| Gross sectional area of under plate | 3.73 |
| Net sectional area of under plate | 2.29 |
| Bearing surface of rivets | 1.44 |
| Shearing area of rivets (".77 diameter) | 2.33 |

| Loads applied. | Elongation in 10 inches. | Permanent set. | Remarks. |
|---|---|---|---|
| *Pounds.* | *Inch.* | *Inch.* | |
| 5,000 | 0. | | |
| 10,000 | .0005 | | |
| 20,000 | .0012 | | |
| 30,000 | .0029 | | |
| 35,000 | .0042 | | |
| 5,000 | | .0015 | |
| 40,000 | .0090 | | |
| 45,000 | .0142 | | Joint opened slightly. |
| 50,000 | .0182 | | |
| 5,000 | | .0118 | |
| 55,000 | .0238 | | Joint open ".01. |
| 60,000 | .0350 | | Joint open ".02. |
| 65,000 | .0588 | | Joint open ".04. |
| 70,000 | .0798 | | |
| 75,000 | .1080 | | |
| 87,450 | | | Ultimate strength. Sheared rivets. |

*Maximum loads on joint.*

| | Pounds per sq. inch. |
|---|---|
| Tensile strain on gross section of plate | 23,445 |
| Tensile strain on net section of plate | 38,190 |
| Compressive strain on bearing surface of rivets | 60,730 |
| Shearing strain on rivets | 37,530 |

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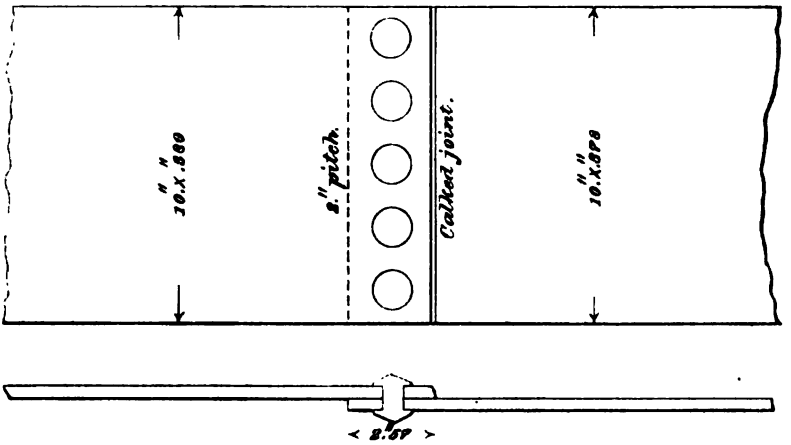
## No. 65.—⅜″ Iron Plate. Joint C . .




$\frac{11}{16}$″ iron rivets, "Burden's best."
Drilled holes, ″.77 diameter.

| | Square inches. |
|---|---|
| Gross sectional area of under plate | 3.78 |
| Net sectional area of under plate | 2.32 |
| Bearing surface of rivets | 1.46 |
| Shearing area of rivets | 2.33 |

| Loads applied. | Elongation in 10 inches. | Permanent set. | Remarks. |
|---|---|---|---|
| *Pounds.* | *Inch.* | *Inch.* | |
| 5,000 | 0. | | |
| 10,000 | .0010 | | |
| 20,000 | .0028 | | |
| 30,000 | .0062 | | |
| 35,000 | .0092 | | |
| 5,000 | | .0040 | |
| 40,000 | .0120 | | Joint opened perceptibly. |
| 45,000 | .0160 | | |
| 50,000 | .0230 | | Joint open ″.01. |
| 5,000 | | .0130 | |
| 55,000 | .0328 | | Joint open ″.02. |
| 60,000 | .0495 | | Joint open ″.04. |
| 65,000 | .0680 | | Joint open ″.05. |
| 70,000 | .0940 | | |
| 75,000 | .1260 | | |
| 84,000 | | | Ultimate strength. Sheared rivets. |

Average elongation of drilled holes, ″.05.

*Maximum loads on joint.*

| | Pounds per sq. inch. |
|---|---|
| Tensile strain on gross section of plate | 22,220 |
| Tensile strain on net section of plate | 36,210 |
| Compressive strain on bearing surface of rivets | 57,530 |
| Shearing strain on rivets | 36,050 |

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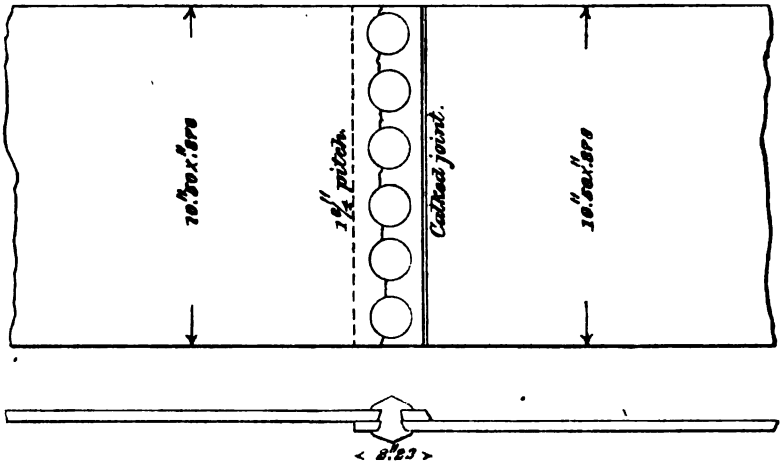
## No. 66.—$\frac{3}{8}$" Iron Plate. Joint D.




$\frac{11}{16}$" iron rivets, "Burden's best."
Punched holes: Punch, ".753 diameter; die, ".774 diameter.

| | Square inches |
|---|---|
| Gross sectional area of upper plate | 3.95 |
| Net sectional area of upper plate | 2.23 |
| Bearing surface of rivets | 1.72 |
| Shearing area of rivets | 2.72 |

| Loads applied. | Elongation in 10 inches. | Permanent set. | Remarks. |
|---|---|---|---|
| *Pounds.* | *Inch.* | *Inch.* | |
| 5,000 | 0. | | |
| 10,000 | .0005 | | |
| 20,000 | .0018 | | |
| 30,000 | .0040 | | |
| 35,000 | .0060 | | |
| 5,000 | | .0022 | |
| 40,000 | .0082 | | |
| 45,000 | .0110 | | |
| 50,000 | .0150 | | |
| 5,000 | | .0080 | |
| 55,000 | .0202 | | Joint opened perceptibly. |
| 60,000 | .0250 | | |
| 65,000 | .0335 | | Joint open ".01. |
| 70,000 | .0460 | | Joint open ".02. |
| 75,000 | .0638 | | Joint open ".03. |
| 80,000 | .0850 | | Joint open ".05. |
| 85,000 | .1600 | | |
| 93,100 | | | Ultimate strength. Fractured plate. |

*Maximum loads on joint.*

| | Pounds per sq. inch. |
|---|---|
| Tensile strain on gross area of plate | 23,570 |
| Tensile strain on net area of plate | 41,750 |
| Compressive strain on bearing surface of rivets | 54,130 |
| Shearing strain on rivets | |

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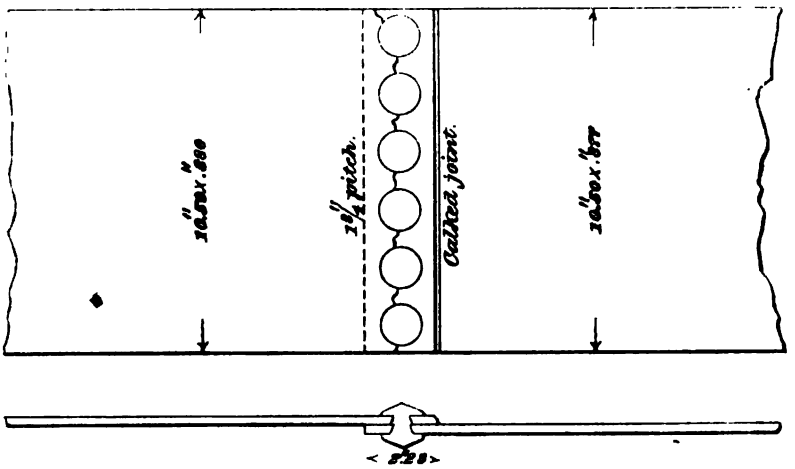
## No. 67.—⅜″ Iron Plate. Joint D . .




11/16″ iron rivets, "Burden's best."
Punched holes: Punch, ".753 diameter; die, ".774 diameter.

Note.—Before the test incipient fractures were observed at the side of the plates in the center line of the rivet holes, probably caused by the machine reveting.

| | Square inches. |
|---|---|
| Gross sectional area of upper plate | 3.99 |
| Net sectional area of upper plate | 2.25 |
| Bearing surface of rivets | 1.74 |
| Shearing area of rivets (".76 diameter) | 2.72 |

| Loads applied. | Elongation in 10 inches. | Permanent set. | Remarks. |
|---|---|---|---|
| *Pounds.* | *Inch.* | *Inch.* | |
| 5,000 | 0. | | |
| 10,000 | .0068 | | |
| 20,000 | .0028 | | |
| 30,000 | .0055 | | |
| 35,000 | .0078 | | |
| 5,000 | | .0025 | |
| 40,000 | .0108 | | |
| 45,000 | .0140 | | |
| 50,000 | .0180 | | |
| 5,000 | | .0080 | |
| 55,000 | .0235 | | |
| 60,000 | .0320 | | Joint opened perceptibly. |
| 65,000 | .0430 | | Joint open ".01. |
| 70,000 | .0585 | | Joint open ".02. |
| 75,000 | .0745 | | Joint open ".03. |
| 80,000 | .1180 | | |
| 92,900 | | | Ultimate strength. Fractured upper plate. |

*Maximum loads on joint.*

| | Pounds per sq. inch. |
|---|---|
| Tensile strain on gross section of plate | 23,280 |
| Tensile strain on net section of plate | 41,290 |
| Compressive strain on bearing surface of rivets | 53,400 |
| Shearing strain on rivets | 34,150 |

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## No. 721.—⅜″ Iron Plate. Set K . .

### Duplicate of K . No. 720.

Upper plate, 10″.32 × ″.395.
Under plate, 10″.32 × ″.395.
1″ iron rivets, hand-driven.
Punched holes: Punch, $1\frac{1}{16}$″ diameter; die, $1\frac{5}{32}$″ diameter.

| | Square inches |
|---|---|
| Gross sectional area of under plate | 4.08 |
| Net sectional area of under plate | 1.88 |
| Bearing surface of rivets | 2.19 |
| Shearing area of rivets | 4.43 |

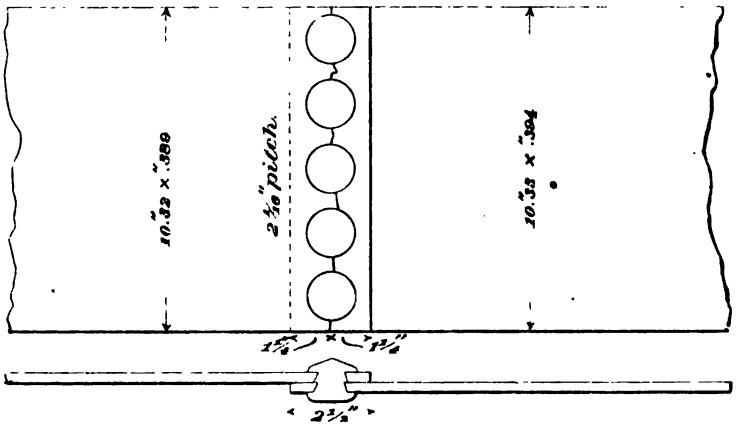
| Loads applied. | Elongation in 10 inches. | Permanent set. | Remarks. |
|---|---|---|---|
| *Pounds.* | *Inch.* | *Inch.* | |
| 5,000 | 0. | | |
| 10,000 | .0015 | | |
| 20,000 | .0040 | | |
| 30,000 | .0080 | | |
| 35,000 | .0098 | | |
| 40,000 | .0125 | | |
| 45,000 | .0155 | | |
| 50,000 | .0200 | | |
| 55,000 | .0240 | | |
| 60,000 | .0290 | | |
| 65,000 | .0350 | | |
| 70,000 | .0455 | | |
| 75,000 | .0560 | | |
| 80,000 | .0670 | | |
| 90,000 | .10 | | |
| 100,000 | .15 | | |
| 110,000 | .21 | | Ultimate strength. |

Fractured under plate across line of rivet holes. Broke suddenly.

*Maximum loads on joint.*

| | Pounds per sq. inch. |
|---|---|
| Tensile strain on gross section of under plate | 26,960 |
| Tensile strain on net section of under plate | 58,510 |
| Compressive strain on bearing surface of rivets | 50,220 |
| Shearing strain on rivets | 24,830 |

## No. 720.—⅜″ Iron Plate. Set K .




1″ iron rivets, hand-driven.
Punched holes: Punch, $1\frac{1}{16}$″ diameter; die, $1\frac{5}{32}$″ diameter.

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| | Square inches. |
|---|---|
| Gross sectional area of under plate | 4.07 |
| Net sectional area of under plate | 1.88 |
| Bearing surface of rivets | 2.19 |
| Shearing area of rivets | 4.43 |

| Loads applied. | Elongation in 10 inches. | Permanent set. | Remarks. |
|---|---|---|---|
| *Pounds.* | *Inch.* | *Inch.* | |
| 5,000 | 0. | | |
| 50,000 | .03 | | |
| 60,000 | .05 | | |
| 70,000 | .06 | | |
| 80,000 | .07 | | |
| 90,000 | .08 | | |
| 100,000 | .12 | | |
| 110,000 | .19 | | |
| 116,000 | .25 | | Ultimate strength. |

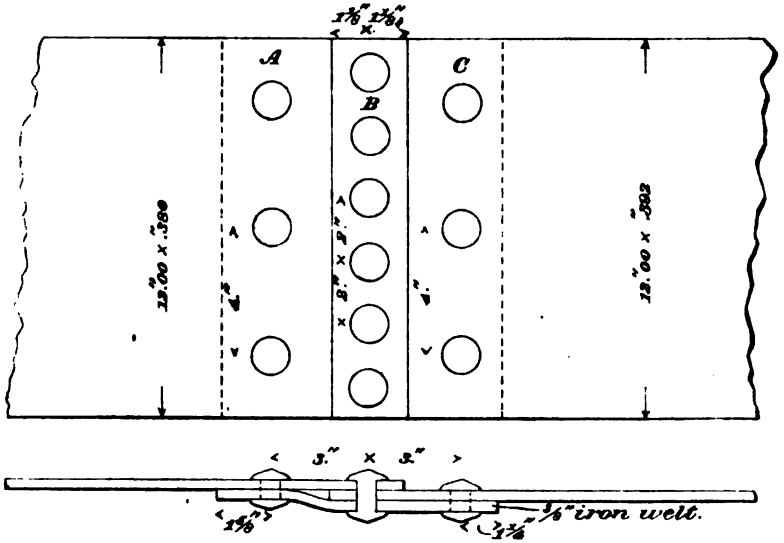
**Joint failed suddenly, fracturing under plate across line of rivet holes.**

*Maximum loads on joint.*

| | Pounds per sq. inch. |
|---|---|
| Tensile strain on gross section of under plate | 28,500 |
| Tensile strain on net section of under plate | 61,700 |
| Compressive strain on bearing surface of rivets | 52,970 |
| Shearing strain on rivets | 26,180 |

**SINGLE-RIVETED LAP JOINTS WITH REINFORCED WELT. ⅜″ IRON PLATE.**

**No. 244.—⅜″ IRON PLATE. JOINT J.**




⅝″ iron rivets, "Burden's best."
Drilled holes, ".72 diameter.
Welt, ⅜″ iron plate.

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| | Square inches. |
|---|---|
| Gross sectional area of upper plate | 4.63 |
| Net sectional area of upper plate through line rivets *B* | 2.96 |
| Net sectional area of upper plate through line rivets *A* | 3.80 |
| Bearing surface of rivets, upper plate | 2.50 |
| Shearing area of rivets (9 rivets), single shear | 3.66 |

| Loads applied. | Elongation in 10 inches. | Permanent set. | Remarks. |
|---|---|---|---|
| *Pounds.* | *Inch.* | *Inch.* | |
| 5,000 | 0. | | |
| 10,000 | .0005 | | |
| 20,000 | .0018 | | |
| 30,000 | .0032 | | |
| 35,000 | .0040 | | |
| 5,000 | | .0005 | |
| 40,000 | .0050 | | |
| 45,000 | .0062 | | |
| 50,000 | .0072 | | |
| 55,000 | .0088 | | |
| 60,000 | .0105 | | |
| 5,000 | | .0030 | |
| 65,000 | .0129 | | Scale started around outside rows of rivets. |
| 70,000 | .0150 | | |
| 75,000 | .0175 | | |
| 80,000 | .0198 | | |
| 85,000 | .0220 | | |
| 90,000 | .0240 | | |
| 95,000 | .0278 | | |
| 100,000 | .0310 | | |
| 5,000 | | .0181 | |
| 105,000 | .0400 | | Micrometer removed. |
| 110,000 | .05 | | |
| 115,000 | .06 | | |
| 120,000 | .06 | | |
| 125,000 | .08 | | |
| 130,000 | .11 | | |
| 135,000 | .14 | | |
| 140,000 | .17 | | |
| 145,000 | .25 | | |
| 147,700 | | | Ultimate strength. Sheared nine rivets, rows *A* and *B*. |

"Cooper lines" run from rivets in row *A*, at an angle of 53 degrees with direction of pull on the specimen.

Elongation of holes, row *A*, ".08; row *B*, ".08.

*Maximum loads on joint.*

| | Pounds per sq. inch. |
|---|---|
| Tensile strain on gross section of upper plate | 31,900 |
| Tensile strain on net section of upper plate through line of rivet holes *B* | 49,900 |
| Tensile strain on net section of upper plate through line of rivet holes *A* | 38,870 |
| Compressive strain on bearing surface of rivets | 59,060 |
| Shearing strain on rivets (9 rivets) | 40,360 |

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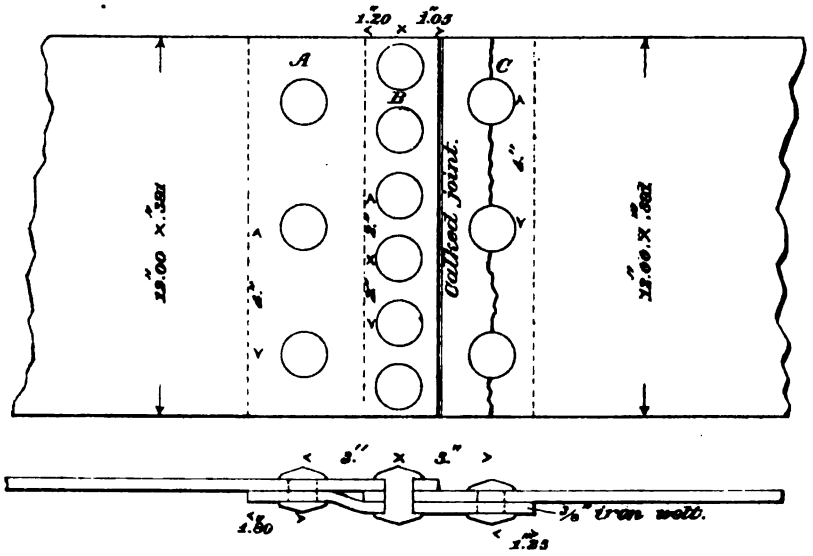
## No. 245.—⅜″ Iron Plate. Joint J . .




¾″ iron rivets, "Burden's best."
Drilled holes, ".82 diameter.
Welt, ⅜″ iron plate.

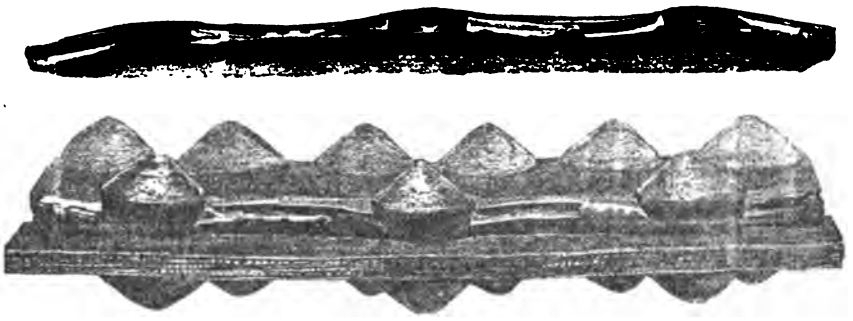
| | Square inches. |
|---|---|
| Gross sectional area of under plate | 4.69 |
| Net sectional area of under plate through line of rivet holes *B* | 2.77 |
| Net sectional area of under plate through line of rivet holes *C* | 3.74 |
| Bearing surface of nine rivets (".82 diameter) | 2.89 |
| Shearing area of nine rivets, single shear | 4.75 |

| Loads applied. | Elongation in 10 inches. | Permanent set. | Remarks. |
|---|---|---|---|
| *Pounds.* | *Inch.* | *Inch.* | |
| 5,000 | 0. | | |
| 10,000 | .0005 | | |
| 20,000 | .0011 | | |
| 30,000 | .0025 | | |
| 35,000 | .0030 | | |
| 5,000 | | .0005 | |
| 40,000 | .0038 | | |
| 50,000 | .0050 | | |
| 60,000 | .0070 | | |
| 5,000 | | .0019 | |
| 70,000 | .0120 | | |
| 75,000 | .0150 | | |
| 80,000 | .0175 | | Joint opened perceptibly. |
| 85,000 | .0195 | | |
| 90,000 | .0220 | | Joint open ".01. |
| 95,000 | .0245 | | |
| 100,000 | .0280 | | |
| 5,000 | | .0165 | |
| 105,000 | .0310 | | |
| 110,000 | .0350 | | |
| 115,000 | .0435 | | Joint open ".02. |
| 120,000 | .0550 | | Micrometer removed. |
| 125,000 | .07 | | |
| 130,000 | .09 | | Joint open about ".04. |
| 135,000 | .10 | | |
| 140,000 | .13 | | |
| 145,000 | .18 | | |
| 163,700 | | | Ultimate strength. Fractured lower plate through outside line of rivet holes. |

Digitized by Google

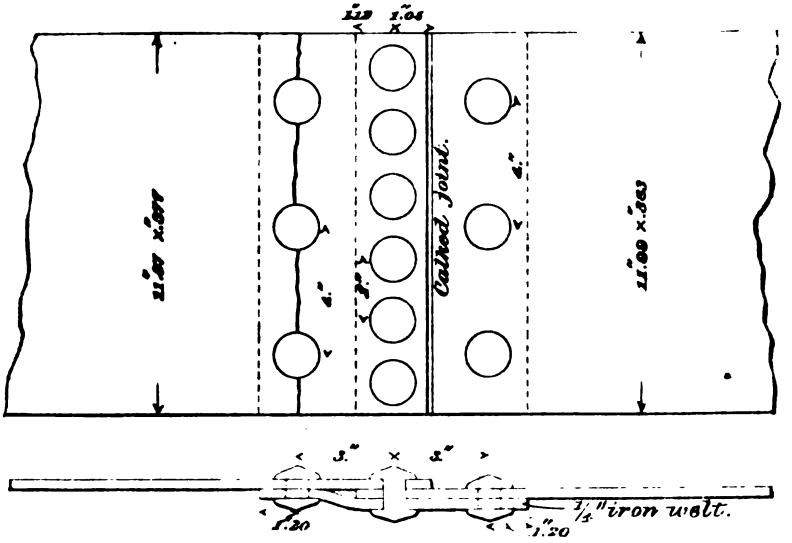
*Maximum loads on joint.*

| | Pounds per sq. inch. |
|---|---|
| Tensile strain on gross section of under plate | 34,900 |
| Tensile strain on net section of under plate through line of rivets *B* | 59,100 |
| Tensile strain on net section of under plate through line of rivets *C* | 43,770 |
| Compressive strain on bearing surface of rivets (9) | 56,640 |
| Shearing strain on nine rivets (single shear) | 34,460 |



Photograph Joint No. 245.

## No. 296.—⅜″ Iron Plate. Joint J J.




¾″ iron rivets, "Burden's best."
Drilled holes, ″.82 diameter.

| | Square inches. |
|---|---|
| Gross sectional area of upper plate | 4. 51 |
| Net sectional area of upper plate through line of three rivet holes | 3. 59 |
| Bearing surface of rivets | 2. 78 |
| Shearing area of rivets (single shear, 9 rivets) | 4. 75 |

Digitized by Google

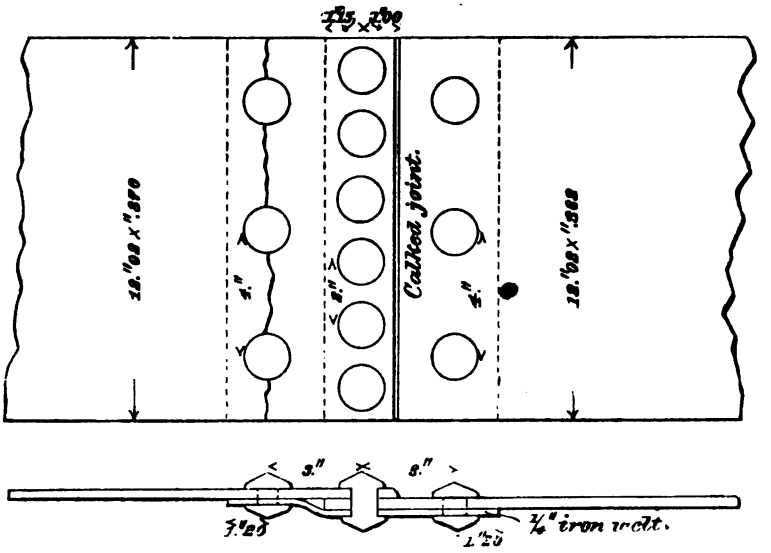
| Loads applied. | Elongation in 10 inches. | Permanent set. | Remarks. |
|---|---|---|---|
| *Pounds.* | *Inch.* | *Inch.* | |
| 5,000 | 0. | | |
| 10,000 | .0002 | | |
| 20,000 | .0010 | | |
| 30,000 | .0020 | | |
| 35,000 | .0030 | | |
| 5,000 | | .0005 | |
| 40,000 | .0038 | | |
| 50,000 | .0068 | | |
| 60,000 | .0108 | | |
| 70,000 | .0150 | | |
| 80,000 | .0190 | | |
| 90,000 | .0245 | | |
| 100,000 | .0318 | | |
| 110,000 | .0430 | | |
| 120,000 | .07 | | |
| 130,000 | .10 | | |
| 140,000 | .16 | | |
| 161,000 | | | Ultimate strength. |

**Fractured upper plate through rivet holes line *A*.**
**Fibrous fracture.**

*Maximum loads on joint.*

| | Pounds per sq. inch. |
|---|---|
| **Tensile strain on gross section of upper plate** | 35,700 |
| **Tensile strain on net section of upper plate across row of three rivet holes** | 44,840 |
| **Compressive strain on bearing surface of rivets** | 57,910 |
| **Shearing strain on rivets (9 rivets, single shear)** | 33,890 |

## No. 297.—⅜″ Iron Plate. Joint J J . .




**⅜″ iron rivets, "Burden's best."**
**Drilled holes, ".82 diameter.**

| | Square inches. |
|---|---|
| **Gross sectional area of upper plate** | 4.45 |
| **Net sectional area of upper plate through line of three rivet holes** | 3.54 |
| **Bearing surface of rivets** | 2.73 |
| **Shearing area of rivets (single shear, 9 rivets)** | 4.75 |

Digitized by Google

| Loads applied. | Elongation in 10 inches. | Permanent set. | Remarks. |
|---|---|---|---|
| *Pounds.* | *Inch.* | *Inch.* | |
| 5,000 | 0. | | |
| 10,000 | .0005 | | |
| 20,000 | .0018 | | |
| 30,000 | .0030 | | |
| 35,000 | .0038 | | |
| 5,000 | | .0005 | |
| 40,000 | .0045 | | |
| 45,000 | .0050 | | |
| 50,000 | .0060 | | |
| 55,000 | .0070 | | |
| 60,000 | .0090 | | |
| 65,000 | .0115 | | |
| 70,000 | .0145 | | |
| 75,000 | .0180 | | |
| 80,000 | .0208 | | |
| 85,000 | .0230 | | |
| 90,000 | .0268 | | |
| 95,000 | .0292 | | |
| 100,000 | .0340 | | |
| 110,000 | .0470 | | |
| 120,000 | .08 | | |
| 130,000 | .11 | | |
| 140,000 | .17 | | |
| 151,100 | | | Ultimate strength. |

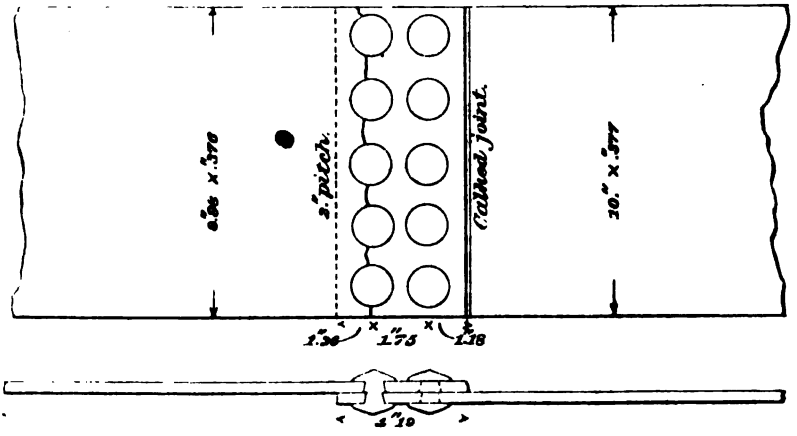
Fractured upper plate through outside row of rivet holes. Fibrous fracture.

*Maximum loads on joint.*

| | Pounds per sq. inch |
|---|---|
| Tensile strain on gross section of upper plate | 33,950 |
| Tensile strain on net section of upper plate through row of three rivet holes | 42,680 |
| Compressive strain on bearing surface of rivets | 55,350 |
| Shearing strain on rivets | 31,810 |

## DOUBLE-RIVETED LAP JOINTS ⅜″ IRON PLATE.

### No. 68.—⅜″ Iron Plate. Joint F.




11/16″ iron rivets, "Burden's best."
Punched holes: Punch, ".753 diameter; die, ".774 diameter.

Digitized by Google

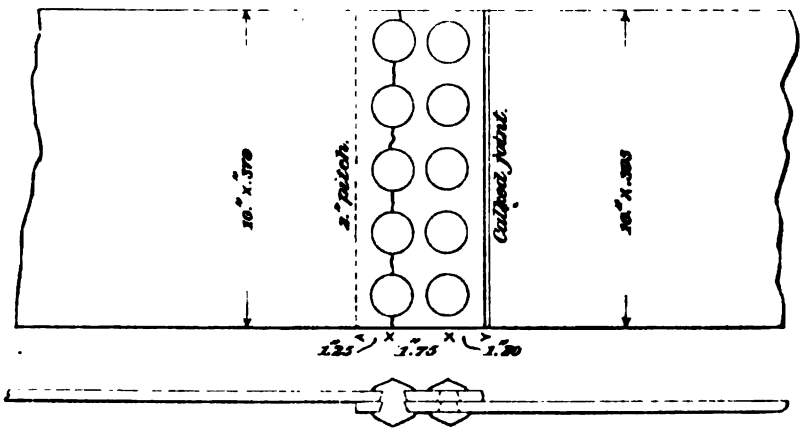
| | Square inches. |
|---|---|
| Gross sectional area of upper plate | 3.75 |
| Net sectional area of upper plate | 2.32 |
| Bearing surface of rivets | 2.87 |
| Shearing area of rivets (".76 diameter) | 4.54 |

| Loads applied. | Elongation in 10 inches. | Permanent set. | Remarks. |
|---|---|---|---|
| *Pounds.* | *Inch.* | *Inch.* | |
| 5,000 | 0. | | |
| 10,000 | .0005 | | |
| 20,000 | .0020 | | |
| 30,000 | .0040 | | |
| 35,000 | .0050 | | |
| 5,000 | | .0010 | |
| 40,000 | .0068 | | |
| 45,000 | .0080 | | |
| 50,000 | .0100 | | |
| 55,000 | .0125 | | |
| 60,000 | .0155 | | |
| 65,000 | .0195 | | Joint opened perceptibly. |
| 70,000 | .0238 | | Joint open ".01. |
| 5,000 | | .0140 | |
| 75,000 | .0285 | | Joint open ".03. |
| 80,000 | .0335 | | Joint open ".04. |
| 85,000 | .0392 | | |
| 90,000 | .0460 | | Joint open ".05. |
| 95,000 | .0530 | | |
| 112,400 | | | Ultimate strength. Fractured upper plate. |

*Maximum loads on joint.*

| | Pounds per sq. inch. |
|---|---|
| Tensile strain on gross area of plate | 29,970 |
| Tensile strain on net section of plate | 48,450 |
| Compressive strain on bearing surface of rivets | 39,160 |
| Shearing strain on rivets | 24,760 |

## No. 69.—⅜" Iron Plate. Joint F . .




$\frac{11}{16}$" iron rivets, "Burden's best."
Punched holes: Punch, ".753 diameter; die, ".774 diameter.

| | Square inches. |
|---|---|
| Gross sectional area of upper plate | 3.79 |
| Net sectional area of upper plate | 2.34 |
| Bearing surface of rivets | 2.89 |
| Shearing area of rivets (".76 diameter) | 4.54 |

Digitized by Google

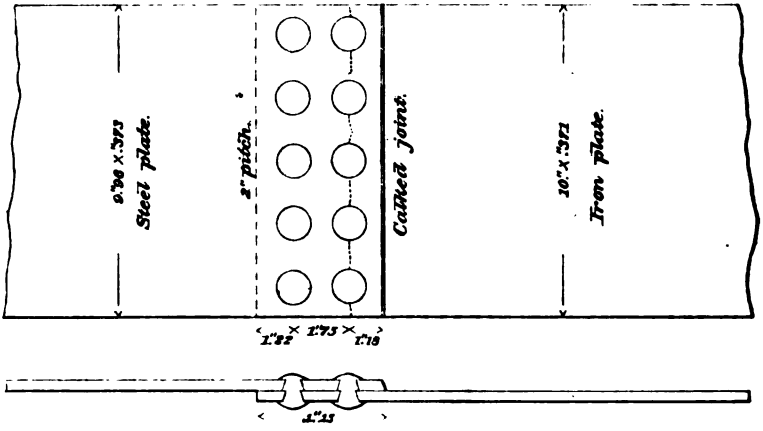
| Loads applied. | Elongation in 10 inches. | Permanent set. | Remarks. |
|---|---|---|---|
| *Pounds.* | *Inch.* | *Inch.* | |
| 5,00 | 0. | | |
| 10,000 | .0005 | | |
| 20,000 | .0020 | | |
| 30,000 | .0032 | | |
| 35,000 | .0045 | | |
| 5,000 | | .0006 | |
| 40,000 | .0058 | | |
| 45,000 | .0071 | | |
| 50,000 | .0082 | | |
| 55,000 | .0102 | | |
| 60,000 | .0125 | | |
| 65,000 | .0151 | | |
| 70,000 | .0182 | | Joint opened perceptibly. |
| 5,000 | | .0070 | |
| 75,000 | .0231 | | |
| 80,000 | .0280 | | Joint open ".01+. |
| 85,000 | .0340 | | Joint open ".02. |
| 90,000 | .0400 | | Joint open ".03. |
| 95,000 | .0485 | | |
| 118,700 | | | Ultimate strength. Fractured upper plate. |

*Maximum loads on joint.*

| | Pounds per sq. inch. |
|---|---|
| Tensile strain on gross area of plate | 31,320 |
| Tensile strain on net area of plate | 50,730 |
| Compressive strain on bearing surface of rivets | 41,070 |
| Shearing strain on rivets | 26,150 |

Photograph of fractured plate, Joint No. 69, showing eccentricity of rivet heads; also showing scale started off rivet heads caused by the bending of the joint plates.

## No. 58.—$\frac{3}{8}$" Iron and Steel Plate. Joint F . . .




$\frac{11}{16}$" iron rivets, "Burden's best."
Punched holes: Punch, ".753 diameter; die, ".774 diameter.

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| | Square inches. |
|---|---|
| Gross sectional area of iron plate | 3.71 |
| Net sectional area of iron plate | 2.29 |
| Bearing surface of rivets | 2.63 |
| Shearing area of rivets (".76 diameter) | 4.54 |

| Loads applied. | Elongation in 10 inches. | Permanent set. | Remarks. |
|---|---|---|---|
| *Pounds.* | *Inch.* | *Inch.* | |
| 5,000 | 0. | | |
| 10,000 | .0010 | | |
| 20,000 | .0025 | | |
| 30,000 | .0042 | | |
| 40,000 | .0070 | | |
| 45,000 | .0081 | | |
| 50,000 | .0100 | | |
| 5,000 | | .0038 | |
| 55,000 | .0120 | | |
| 60,000 | .0140 | | Joint opened perceptibly. |
| 65,000 | .0162 | | |
| 70,000 | .0192 | | Joint open ".01. |
| 5,000 | | .0090 | |
| 75,000 | .0238 | | Joint open ".02. |
| 80,000 | .0280 | | |
| 85,000 | .0329 | | Joint open ".03. |
| 90,000 | .0378 | | |
| 5,000 | | .0258 | |
| 95,000 | .0435 | | Joint open ".04. |
| 100,000 | .0508 | | Joint open ".05. |
| 105,000 | .0608 | | |
| 110,000 | .0768 | | |
| 115,000 | | | Ultimate strength. |

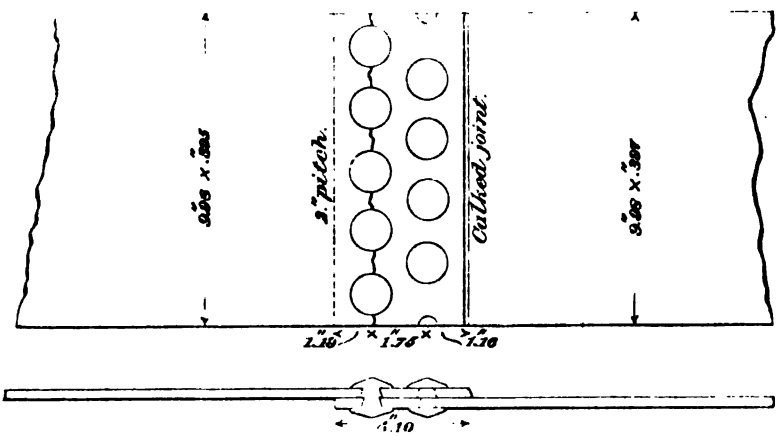
Fractured lower plate across line of rivet holes. Fibrous fractures, metal slightly drawn down.

NOTE.—Through mistake an iron and a steel plate were riveted together.

*Maximum loads on joint.*

| | Pounds per sq. inch. |
|---|---|
| Tensile strain on gross section of iron plate | 31,000 |
| Tensile strain on net section of iron plate | 50,220 |
| Compressive strain on bearing surface of rivets | 40,640 |
| Shearing strain on rivets | 25,330 |

## No. 70.—⅜" IRON PLATE. JOINT G.




11/16" iron rivets, "Burden's best."
Punched holes: Punch, ".753 diameter; die, ".774 diameter.

Digitized by Google

| | Square inches. |
|---|---|
| Gross sectional area of upper plate | 3.94 |
| Net sectional area of upper plate | 2.43 |
| Bearing surface of rivets | 2.71 |
| Shearing area of rivets (".76 diameter) | 4.08 |

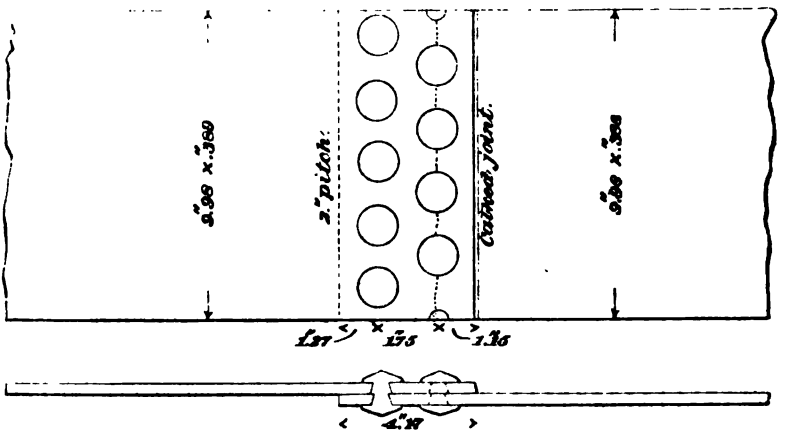
| Loads applied. | Elongation in 10 inches. | Permanent set. | Remarks. |
|---|---|---|---|
| *Pounds.* | *Inch.* | *Inch.* | |
| 5,000 | 0. | | |
| 10,000 | .0005 | | |
| 20,000 | .0020 | | |
| 30,000 | .0038 | | |
| 35,000 | .0048 | | |
| 5,000 | | .0010 | |
| 40,000 | .0068 | | |
| 45,000 | .0079 | | |
| 50,000 | .0095 | | |
| 55,000 | .0120 | | |
| 60,000 | .0145 | | |
| 65,000 | .0178 | | |
| 70,000 | .0210 | | Joint opened perceptibly. |
| 75,000 | .0258 | | Joint open ".01. |
| 5,000 | | .0141 | |
| 80,000 | .0300 | | |
| 85,000 | .0348 | | Joint open ".02. |
| 90,000 | .0410 | | Joint open ".03. |
| 95,000 | .0488 | | Joint open ".04. |
| 100,000 | .0630 | | |
| 112,400 | | | Ultimate strength. Fractured upper plate through row of five rivet holes. |

Fractured plate shows imperfect welds in rolling.

*Maximum loads on joint.*

| | Pounds per sq. inch. |
|---|---|
| Tensile strain on gross section of plate | 28,530 |
| Tensile strain on net section of plate | 46,255 |
| Compressive strain on bearing surface of rivets | 41,480 |
| Shearing strain on rivets | 27,550 |

## No. 71.—⅜" Iron Plate. Joint G . .




$\frac{11}{16}$" iron rivets, "Burden's best."
Punched holes: Punch, ".753 diameter; die, ".774 diameter.

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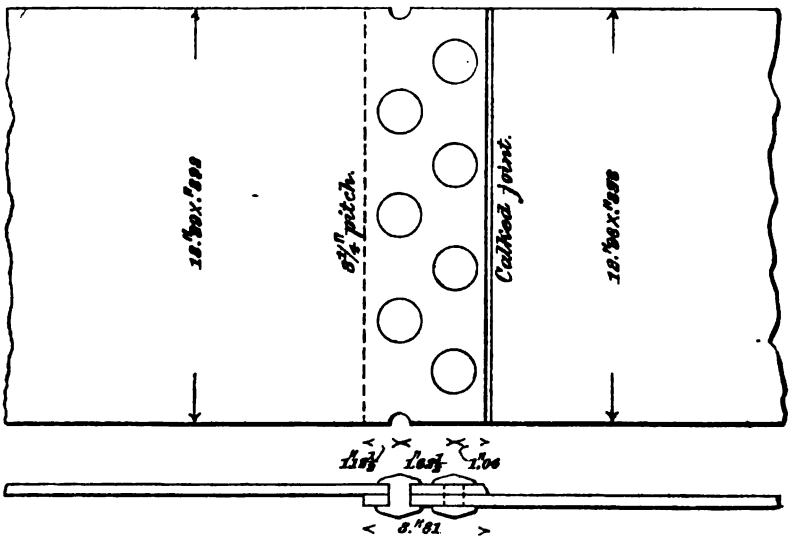
| | Square inches. |
|---|---|
| Gross sectional area of under plate | 3.87 |
| Net sectional area of under plate | 2.39 |
| Bearing surface of rivets | 2.67 |
| Shearing area of rivets (".76 diameter) | 4.08 |

| Loads applied. | Elongation in 10 inches. | Permanent set. | Remarks. |
|---|---|---|---|
| *Pounds.* | *Inch.* | *Inch.* | |
| 5,000 | 0. | | |
| 10,000 | .0005 | | |
| 20,000 | .0020 | | |
| 30,000 | .0040 | | |
| 35,000 | .0050 | | |
| 5,000 | | .0005 | |
| 40,000 | .0065 | | |
| 45,000 | .0080 | | |
| 50,000 | .0105 | | |
| 55,000 | .0130 | | |
| 60,000 | .0160 | | Joint opened perceptibly. |
| 65,000 | .0198 | | Joint open ".01. |
| 70,000 | .0240 | | Joint open ".02. |
| 75,000 | .0290 | | Joint open ".03. |
| 80,000 | .0348 | | Joint open ".04. |
| 85,000 | .0399 | | |
| 90,000 | .0468 | | |
| 95,000 | .0555 | | |
| 100,000 | .0680 | | |
| 110,200 | | | Ultimate strength. Fractured the under plate through line of four rivet holes. |

*Maximum loads on joint.*

| | Pounds per sq. inch. |
|---|---|
| Tensile strain on gross section of plate | 28,475 |
| Tensile strain on net section of plate | 46,110 |
| Compressive strain on bearing surface of rivets | 41,270 |
| Shearing strain on rivets | 27,010 |

## No. 81.—$\frac{3}{8}$" Iron Plate. Joint I.




$\frac{11}{16}$" iron rivets, "Burden's best."
Drilled holes, ".75 diameter.



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| | Square inches. |
|---|---|
| Gross sectional area of upper plate | 5.09 |
| Net sectional area of upper plate | 3.91 |
| Bearing surface of rivets | 2.06 |
| Shearing area of rivets (".75 diameter) | 3.09 |

| Loads applied. | Elongation in 10 inches. | Permanent set. | Remarks. |
|---|---|---|---|
| *Pounds.* | *Inch.* | *Inch.* | |
| 5,000 | 0. | | |
| 10,000 | 0. | | |
| 20,000 | .0002 | | |
| 30,000 | .0009 | | |
| 40,000 | .0020 | | |
| 50,000 | .0050 | | |
| 55,000 | .0070 | | |
| 60,000 | .0098 | | |
| 65,000 | .0120 | | |
| 5,000 | | .0050 | |
| 70,000 | .0150 | | |
| 75,000 | .0190 | | |
| 80,000 | .0250 | | |
| 85,000 | .0362 | | Joint opened perceptibly. |
| 90,000 | .0458 | | Joint open ".01+ |
| 95,000 | .0580 | | Joint open ".03. |
| 100,000 | .0708 | | Joint open ".06. |
| 105,000 | .0860 | | |
| 110,000 | .1080 | | |
| 115,000 | .1350 | | |
| 120,900 | | | Ultimate strength. Sheared rivets. |

Average elongation of holes, ".04.

*Maximum loads on joint.*

| | Pounds per sq. inch. |
|---|---|
| Tensile strain on gross section of plate | 23,750 |
| Tensile strain on net section of plate | 30,920 |
| Compressive strain on bearing surface of rivets | 58,700 |
| Shearing strain on rivets | 39,130 |

## No. 82.—$\frac{3}{8}$" Iron Plate. Joint I . .

Same style of joint as No. 81.
Upper plate, 12".97 × ".395.
Under plate, 12".97 × ".395.
$\frac{11}{16}$" iron rivets, "Burden's best."
Drilled holes, ".75 diameter.

| | Square inches. |
|---|---|
| Gross sectional area of plate | 5.12 |
| Net sectional area of plate | 3.94 |
| Bearing surface of rivets | 2.07 |
| Shearing area of rivets (".75 diameter) | 3.09 |

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| Loads applied. | Elongation in 10 inches. | Permanent set. | Remarks. |
|---|---|---|---|
| *Pounds.* | *Inch.* | *Inch.* | |
| 5,000 | 0. | | |
| 10,000 | .0002 | | |
| 20,000 | .0012 | | |
| 30,000 | .0028 | | |
| 40,000 | .0050 | | |
| 50,000 | .0120 | | |
| 55,000 | .0140 | | |
| 60,000 | .0170 | | |
| 65,000 | .0210 | | |
| 5,000 | | .0145 | |
| 70,000 | .0255 | | |
| 75,000 | .0300 | | |
| 80,000 | .0400 | | Joint opened ".01. |
| 85,000 | .0516 | | |
| 90,000 | .0808 | | Joint opened ".02. |
| 95,000 | .0750 | | Joint opened ".04. |
| 100,000 | .0890 | | Joint opened ".06. |
| 105,000 | .1080 | | |
| 118,700 | | | Ultimate strength. Sheared rivets. |

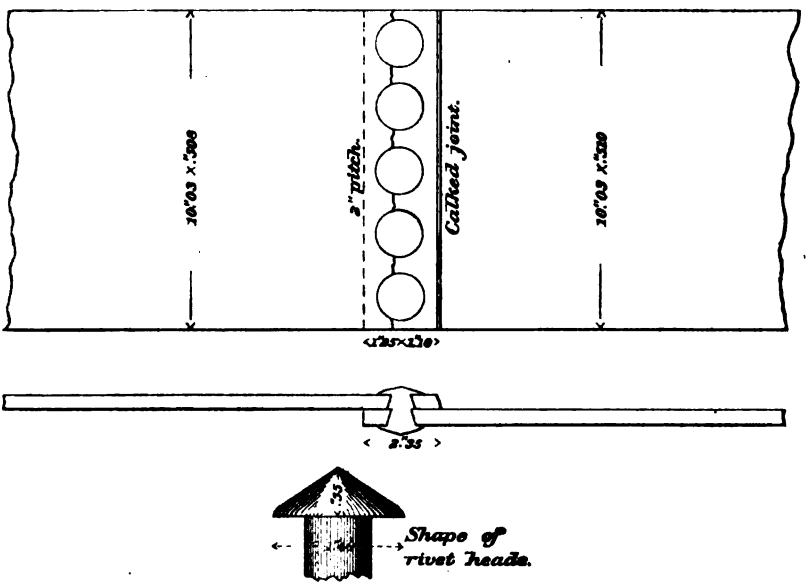
Average elongation of rivet holes, ".06.

*Maximum loads on joint.*

| | Pounds per sq. inch. |
|---|---|
| Tensile strain on gross section of plate | 23,180 |
| Tensile strain on net section of plate | 30,130 |
| Compressive strain on bearing surface of rivets | 57,340 |
| Shearing strain on rivets | 38,41[illegible] |

SINGLE AND DOUBLE RIVETED LAP JOINTS, ½" IRON PLATE.

No. 240.—½" IRON PLATE. JOINT A.




⅞" iron rivets, "Burden's best."
Punched holes: Punch, 1 3/16" diameter; die, 1 5/16" diameter.

Digitized by Google

| | Square inches. |
|---|---|
| Gross sectional area of upper plate | 5.095 |
| Net sectional area of upper plate | 2.91 |
| Bearing surface of rivets | 2.18 |
| Shearing area of rivets (".82 diameter) | 2.64 |

| Loads applied. | Elongation in 10 inches. | Permanent set. | Remarks. |
|---|---|---|---|
| *Pounds.* | *Inch.* | *Inch.* | |
| 5,000 | 0. | | |
| 10,000 | .0008 | | |
| 20,000 | .0020 | | |
| 30,000 | .0042 | | |
| 35,000 | .0068 | | |
| 5,000 | | .0025 | |
| 40,000 | .0108 | | |
| 45,000 | .0148 | | Joint opened perceptibly. |
| 50,000 | .0172 | | |
| 5,000 | | .0085 | |
| 55,000 | .0199 | | |
| 60,000 | .0230 | | |
| 65,000 | .0298 | | Joint open ".01. |
| 70,000 | .0418 | | Joint open ".01½. |
| 5,000 | | .0265 | |
| 10,000 | .0280 | | |
| 20,000 | .0308 | | |
| 30,000 | .0330 | | |
| 40,000 | .0358 | | |
| 50,000 | .0380 | | |
| 5,000 | | .0268 | |
| 10,000 | .0280 | | |
| 20,000 | .0308 | | |
| 30,000 | .0330 | | |
| 40,000 | .0358 | | |
| 50,000 | .0380 | | |
| 70,000 | .0428 | | |
| 75,000 | .0548 | | |
| 80,000 | .0718 | | |
| 5,000 | | .0540 | |
| 10,000 | .0560 | | |
| 20,000 | .0588 | | |
| 30,000 | .0610 | | |
| 40,000 | .0638 | | |
| 50,000 | .0658 | | Micrometer removed. |
| 85,000 | .10 | | Joint open ".04. |
| 90,000 | .15 | | |
| 90,500 | | | Ultimate strength. |

Fractured top plate, the line of the fracture following about ".08 back of center line of rivet holes.

The plate that fractured had the die side in contact with lower plate.

Metal fibrous, except around the punched holes, which was granular; on the punch side of the plate little or no granulation was found, but on the die side the ring of granular metal reached the maximum amount of $\frac{1}{10}$" thickness.

Along the calked edge granular metal was found. At 50,000 pounds tension snapping sounds were heard, which were repeated occasionally till fracture took place. These sounds were attributed to the supposed giving way of the granular metal about the rivet holes, from time to time, as the plates bent at the joint.

Fractures were started about the holes in the under plate.

*Maximum loads on joint.*

| | Pounds per sq. inch. |
|---|---|
| Tensile strain on gross section of plate | 17,760 |
| Tensile strain on net section of plate | 31,100 |
| Compressive strain on bearing surface of rivets | 41,500 |
| Shearing strain on rivets | 34,280 |

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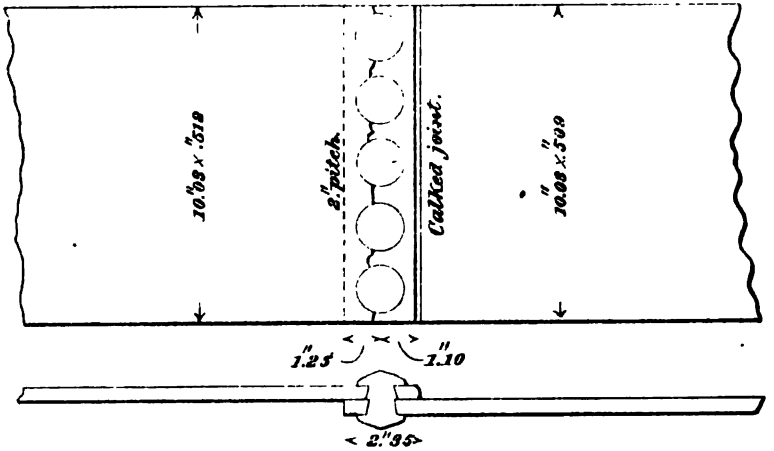
## No. 241.—½″ Iron Plate. Joint A . .




⅞″ iron rivets, "Burden's best."
Punched holes: Punch, $\frac{13}{16}$″ diameter; die, $\frac{15}{16}$″ diameter.

| | Square inches. |
|---|---|
| Gross sectional area of upper plate | 5.14 |
| Net sectional area of upper plate | 2.94 |
| Bearing surface of rivets | 2.20 |
| Shearing area of rivets (″.82 diameter) | 2.64 |

| Loads applied. | Elongation in 10 inches. | Permanent set. | Remarks. |
|---|---|---|---|
| *Pounds.* | *Inch.* | *Inch.* | |
| 5,000 | 0. | | |
| 10,000 | .0005 | | |
| 20,000 | .0020 | | |
| 30,000 | .0038 | | |
| 35,000 | .0052 | | |
| 5,000 | | .0019 | |
| 10,000 | .0021 | | |
| 20,000 | .0035 | | |
| 30,000 | .0049 | | |
| 35,000 | .0055 | | |
| 5,000 | | .0019 | |
| 10,000 | .0022 | | |
| 20,000 | .0038 | | |
| 30,000 | .0049 | | |
| 35,000 | .0058 | | |
| 40,000 | .0085 | | |
| 45,000 | .0121 | | |
| 50,000 | .0155 | | |
| 5,000 | | .0080 | |
| 10,000 | .0085 | | |
| 20,000 | .0100 | | |
| 30,000 | .0112 | | |
| 40,000 | .0132 | | |
| 50,000 | .0160 | | |
| 55,000 | .0190 | | |
| 60,000 | .0221 | | |
| 65,000 | .0268 | | Joint opened perceptibly. |
| 70,000 | .0370 | | Joint opened ″.01. |
| 75,000 | .0500 | | Micrometer removed. |
| 80,000 | .07 | | |
| 85,000 | .09 | | |
| 90,000 | .13 | | |
| 92,300 | | | Ultimate strength. Fractured upper plate. |
| 70,000 | | | Load at time of fracture. |

Fractured in the same manner as A . Same description of appearance of fractures.

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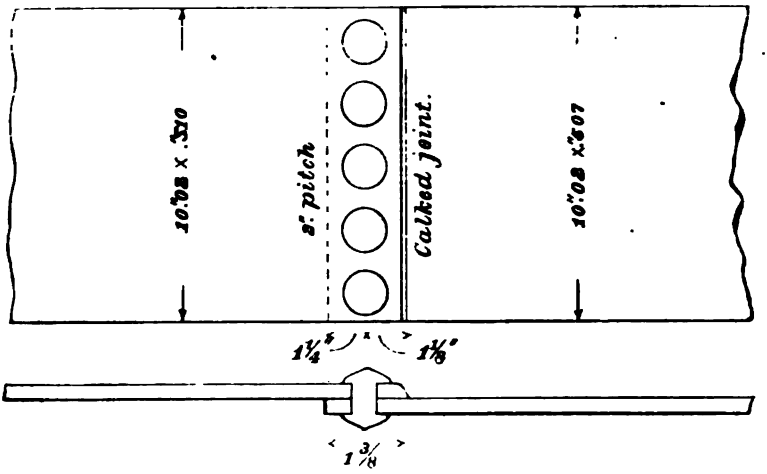
*Maximum loads on joint.*

| | Pounds per sq. inch. |
|---|---|
| Tensile strain on gross section of plate | 17,690 |
| Tensile strain on net section of plate | 31,395 |
| Compressive strain on bearing surface of rivets | 41,955 |
| Shearing strain on rivets | 34,960 |

## No. 292.—½″ Iron Plate. Joint A A.




⅝″ iron rivets, "Burden's best."
Drilled holes, ".81 diameter.

| | Square inches. |
|---|---|
| Gross sectional area of lower plate | 5.08 |
| Net sectional area of lower plate | 3.03 |
| Bearing surface of rivets | 2.05 |
| Shearing area of rivets (".81 diameter) | 2.56 |

| Loads applied. | Elongation in 10 inches. | Permanent set. | Remarks. |
|---|---|---|---|
| *Pounds.* | *Inch.* | *Inch.* | |
| 5,000 | 0. | | |
| 10,000 | .0002 | | |
| 20,000 | .0008 | | |
| 30,000 | .0022 | | |
| 35,000 | .0032 | | |
| 5,000 | | .0006 | |
| 40,000 | .0065 | | |
| 45,000 | .0108 | | |
| 50,000 | .0148 | | Joint opened perceptibly. |
| 5,000 | | .0085 | |
| 55,000 | .0190 | | |
| 60,000 | .0222 | | |
| 65,000 | .0280 | | Joint opened ".01. |
| 70,000 | .0405 | | |
| 75,000 | .0570 | | Joint open ".02. |
| 80,000 | .0760 | | |
| 85,000 | .10 | | Joint open ".05. |
| 90,000 | .13 | | |
| 95,000 | .16 | | |
| 98,100 | .19 | | Ultimate strength. Sheared rivets. |

Average elongation of rivet holes, ".09.

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*Maximum loads on joint.*

| | Pounds per sq. inch. |
|---|---|
| Tensile strain on gross section of under plate | 19,130 |
| Tensile strain on net section of under plate | 32,376 |
| Compressive strain on bearing surface of rivets | 47,850 |
| Shearing strain on rivets | 38,020 |

## No. 293.—½" Iron Plate. Joint A A . .

Same style of joint as No. 292.
Upper plate, 10".03 × ".510.
Under plate, 10".03 × ".510.
¾" iron rivets, "Burden's best."
Drilled holes, ".81 diameter.

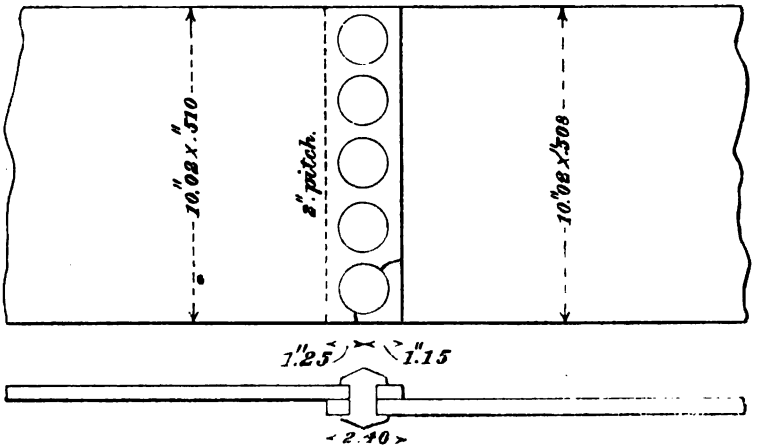
| | Square inches. |
|---|---|
| Gross sectional area of plate | 5.12 |
| Net sectional area of plate | 3.05 |
| Bearing surface of rivets | 2.07 |
| Shearing area of rivets | 2.58 |

| Loads applied. | Elongation in 10 inches. | Permanent set. | Remarks. |
|---|---|---|---|
| *Pounds.* | *Inch.* | *Inch.* | |
| 5,000 | 0. | | |
| 10,000 | .0006 | | |
| 20,000 | .0019 | | |
| 25,000 | .0028 | | |
| 30,000 | .0038 | | |
| 35,000 | .0060 | | |
| 5,000 | | .0022 | |
| 40,000 | .0092 | | |
| 45,000 | .0130 | | |
| 50,000 | .0175 | | |
| 60,000 | .0275 | | |
| 70,000 | .0490 | | |
| 80,000 | .0860 | | |
| 90,000 | .15 | | |
| 100,000 | .23 | | |
| 101,200 | .24 | | Ultimate strength. Sheared rivets. |

*Maximum loads on joint.*

| | Pounds per sq. inch. |
|---|---|
| Tensile strain on gross section of plate | 19,765 |
| Tensile strain on net section of plate | 33,180 |
| Compressive strain on bearing surface of rivets | 48,890 |
| Shearing strain on rivets | 39,220 |

## No. 327.—½" Wrought-iron Plate. Joint A A A




¾" steel rivets; $\frac{13}{16}$" drilled holes.

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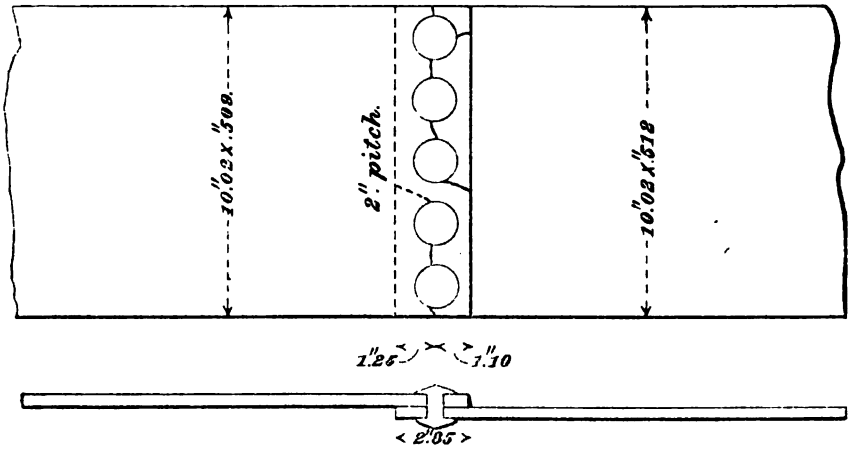
| | Square inches. |
|---|---|
| Gross sectional area of upper plate | 5.11 |
| Net sectional area of upper plate | 3.04 |
| Bearing surface of rivets | 2.06 |
| Shearing area of rivets (".81 diameter) | 2.58 |

Ultimate strength, 121,300 pounds.
Sheared four rivets and tore out upper plate at one end rivet.
Fractures started at rivet holes in upper plate.
Average elongation of rivet holes in upper plate, ".15.
Average elongation of rivet holes in lower plate, ".14.

*Maximum loads on joint.*

| | Pounds per sq. inch. |
|---|---|
| Tensile strain on gross section of upper plate | 23,740 |
| Tensile strain on net section of upper plate | 39,900 |
| Compressive strain on bearing surface of rivets | 58,880 |
| Shearing strain on rivets | 47,020 |

## No. 328.—½" Wrought Iron. Joint A A A . .




⅝" steel rivets; $\frac{13}{16}$" drilled holes.

| | Square inches. |
|---|---|
| Gross sectional area of upper plate | 5.10 |
| Net sectional area of upper plate | 3.04 |
| Bearing surface of rivets | 2.06 |
| Shearing area of rivets | 2.58 |

Ultimate strength, 123,400 pounds.
Fractured plates opposite three rivets in upper plate and opposite two rivets in under plate.
Seam in upper plate 4" wide.

*Maximum loads on joint.*

| | Pounds per sq. inch. |
|---|---|
| Tensile strain on gross section of upper plate | 24,200 |
| Tensile strain on net section of upper plate | 40,590 |
| Compressive strain on bearing surface of rivets | 59,900 |
| Shearing strain on rivets | 47,830 |

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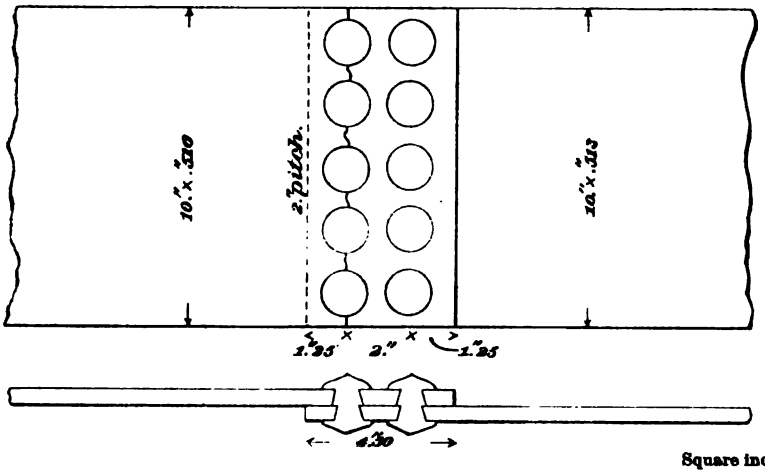
## No. 329.—½″ Wrought-iron Plate. Joint C




| | Square inches. |
|---|---|
| Gross sectional area of upper plate | 5.16 |
| Net sectional area of upper plate | 2.96 |
| Bearing surface of rivets | 2.20 |
| Shearing area of rivets | 5.19 |

| Loads applied. | Elongation in 10 inches. | Permanent set. | Remarks. |
|---|---|---|---|
| *Pounds.* | *Inch.* | *Inch.* | |
| 5,000 | 0. | | |
| 10,000 | .0008 | | |
| 20,000 | .0015 | | |
| 30,000 | .0033 | | |
| 35,000 | .0042 | | |
| 5,000 | | .0005 | |
| 40,000 | .0055 | | |
| 50,000 | .0080 | | |
| 5,000 | | .0018 | |
| 55,000 | .0099 | | |
| 60,000 | .0116 | | |
| 65,000 | .0142 | | |
| 70,000 | .0170 | | |
| 75,000 | .0212 | | |
| 80,000 | .0250 | | |
| 85,000 | .0300 | | |
| 90,000 | .0348 | | |
| 95,000 | .0400 | | |
| 100,000 | .0470 | | |
| 5,000 | | .0338 | |
| 121,200 | | | Ultimate strength. |

**Fractured upper plate across line of rivet holes.**

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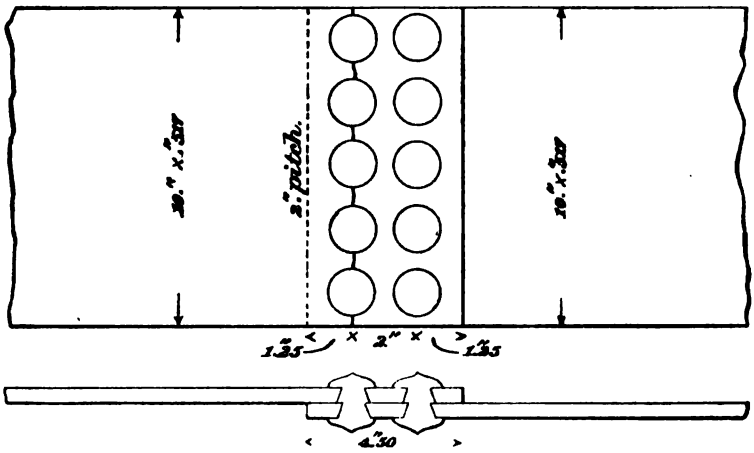
## No. 635.—½″ Iron Plate. Joint C . .




¾″ iron rivets, "Burden's best."
Punched holes: Punch, $\frac{13}{16}$″ diameter; die, $\frac{57}{64}$″ diameter.

| | Square inches. |
|---|---|
| Gross sectional area of plate | 5.17 |
| Net sectional area of plate | 2.97 |
| Bearing surface of rivets | 2.20 |
| Shearing area of rivets | 5.19 |

| Loads applied. | Elongation in 10 inches. | Permanent set. | Remarks. |
|---|---|---|---|
| *Pounds.* | *Inch.* | *Inch.* | |
| 5,000 | 0. | ..... | |
| 10,000 | .0009 | ..... | |
| 20,000 | .0015 | ..... | |
| 30,000 | .0032 | ..... | |
| 35,000 | .0045 | ..... | |
| 5,000 | ..... | .0005 | |
| 40,000 | .0055 | ..... | |
| 50,000 | .0081 | ..... | |
| 5,000 | ..... | .0020 | |
| 55,000 | .0100 | ..... | |
| 60,000 | .0120 | ..... | |
| 65,000 | .0141 | ..... | |
| 70,000 | .0175 | ..... | |
| 75,000 | .0220 | ..... | |
| 80,000 | .0260 | ..... | |
| 85,000 | .0312 | ..... | |
| 90,000 | .0370 | ..... | |
| 95,000 | .0435 | ..... | |
| 100,000 | .0518 | ..... | |
| 5,000 | ..... | .0398 | |
| 127,480 | ..... | ..... | Ultimate strength. |
| 115,000 | ..... | ..... | At time of fracture. |

Fractured upper plate across line of rivet holes.

*Maximum loads on joint.*

| | Pounds per sq. inch. |
|---|---|
| Tensile strain on gross section of plate | 24,660 |
| Tensile strain on net section of plate | 42,920 |
| Compressive strain on bearing surface of rivets | 57,950 |
| Shearing strain on rivets | 24,560 |

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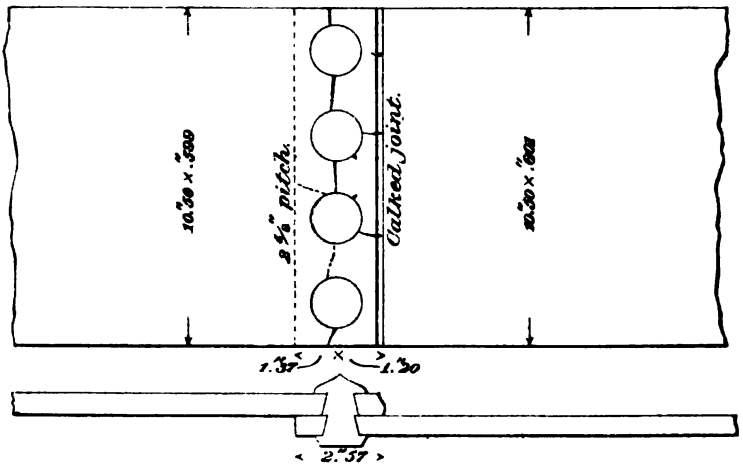
SINGLE AND DOUBLE RIVETED LAP JOINTS, ⅜″ IRON PLATE.

## No. 730.—⅜″ Iron Plate. Set A.




1″ iron rivets, hand-driven.
Punched holes: Punch, $1\frac{1}{16}$″ diameter; die, $1\frac{5}{32}$″ diameter.

| | Square inches. |
|---|---|
| Gross sectional area of upper plate | 6.29 |
| Net sectional area of upper plate | 3.63 |
| Bearing surface of rivets | 2.65 |
| Shearing area of rivets | 3.55 |

| Loads applied. | Elongation in 10 inches. | Permanent set. | Remarks. |
|---|---|---|---|
| *Pounds.* | *Inch.* | *Inch.* | |
| 5,000 | 0. | | |
| 10,000 | .0001 | | |
| 20,000 | .0009 | | |
| 30,000 | .0021 | | |
| 40,000 | .0038 | | |
| 50,000 | .0065 | | |
| 55,000 | .0080 | | |
| 60,000 | .0120 | | |
| 65,000 | .0148 | | |
| 70,000 | .0180 | | |
| 75,000 | .0240 | | |
| 80,000 | .0540 | | |
| 90,000 | .09 | | |
| 95,000 | | | Snapping sound heard. |
| 100,000 | .13 | | |
| 110,000 | .19 | | |
| 120,000 | .27 | | |
| 125,900 | | | Ultimate strength. |

Fractured upper plate across three rivet holes; lower plate fractured across two rivet holes.

*Maximum loads on joint.*

| | Pounds per sq. inch. |
|---|---|
| Tensile strain on gross section of upper plate | 20,020 |
| Tensile strain on net section of upper plate | 34,680 |
| Compressive strain on bearing surface of rivets | 47,510 |
| Shearing strain on rivets | 35,460 |

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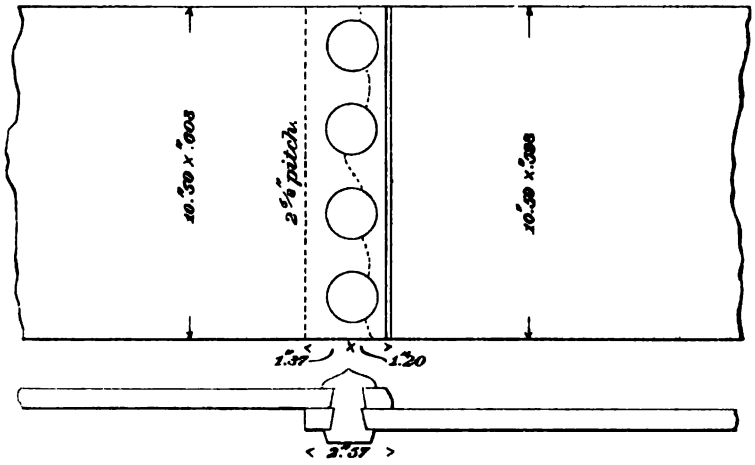
## No. 731.—⅝″ Iron Plate. Set A . .




1″ iron rivets, hand-driven.
Punched holes: Punch, $1\frac{1}{16}$″ diameter; die, $1\frac{5}{32}$″ diameter.

| | Square inches. |
|---|---|
| Gross sectional area of under plate | 6.28 |
| Net sectional area of under plate | 3.68 |
| Bearing surface of rivets | 2.65 |
| Shearing area of rivets | 3.55 |

| Loads applied. | Elongation in 10 inches. | Permanent set. | Remarks. |
|---|---|---|---|
| *Pounds.* | *Inch.* | *Inch.* | |
| 5,000 | 0. | | |
| 10,000 | .0002 | | |
| 20,000 | .0010 | | |
| 30,000 | .0021 | | |
| 40,000 | .0040 | | |
| 45,000 | .0055 | | |
| 50,000 | .0078 | | |
| 55,000 | .0105 | | |
| 60,000 | .0140 | | |
| 65,000 | .0180 | | |
| 70,000 | .0250 | | |
| 75,000 | .0520 | | |
| 80,000 | .0708 | | |
| 90,000 | .09 | | |
| 100,000 | .15 | | |
| 110,000 | .22 | | |
| 120,000 | .29 | | |
| 124,000 | | | Ultimate strength. |

Fractured under plate across line of rivet holes.

*Maximum loads on joint.*

| | Pounds per sq. inch. |
|---|---|
| Tensile strain on gross section of under plate | 19,750 |
| Tensile strain on net section of under plate | 34,230 |
| Compressive strain on bearing surface of rivets | 46,790 |
| Shearing strain on rivets | 34,939 |

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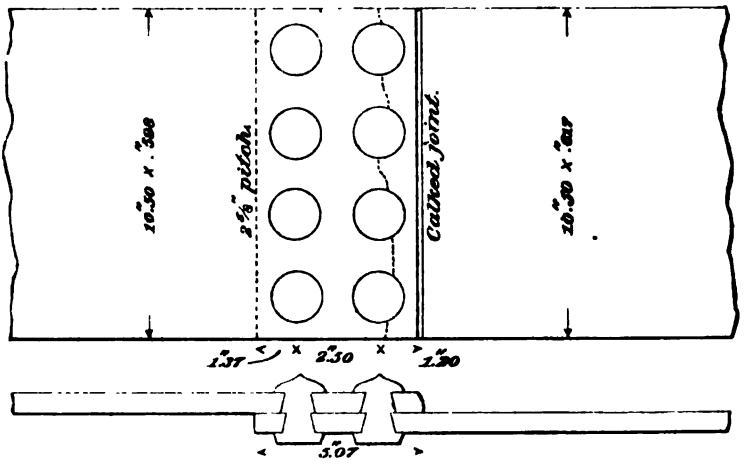
## No. 732.—$\frac{5}{8}$" Iron Plate. Set C.




1" iron rivets, hand-driven.
Punched holes: Punch, $1\frac{1}{16}$" diameter; die, $1\frac{5}{32}$" diameter.

| | Square inches. |
|---|---|
| Gross sectional area of under plate | 6.48 |
| Net sectional area of under plate | 3.74 |
| Bearing surface of rivets | 5.48 |
| Shearing area of rivets | 7.09 |

| Loads applied. | Elongation in 10 inches. | Permanent set. | Remarks. |
|---|---|---|---|
| *Pounds.* | *Inch.* | *Inch.* | |
| 5,000 | 0. | | |
| 10,000 | .0002 | | |
| 20,000 | .0011 | | |
| 30,000 | .0025 | | |
| 40,000 | .0040 | | |
| 50,000 | .0060 | | |
| 55,000 | .0072 | | |
| 60,000 | .0091 | | |
| 65,000 | .0112 | | |
| 70,000 | .0135 | | |
| 75,000 | .0160 | | |
| 80,000 | .0190 | | |
| 85,000 | .0220 | | |
| 90,000 | .0251 | | |
| 95,000 | .0290 | | |
| 100,000 | .0320 | | |
| 105,000 | .0361 | | |
| 110,000 | .0405 | | |
| 130,000 | .08 | | |
| 140,000 | .10 | | |
| 150,000 | .14 | | |
| 160 000 | .17 | | |
| 163,000 | | | Ultimate strength. |

Fractured under plate across line of rivet holes.

*Maximum loads on joint.*

| | Pounds per sq. inch. |
|---|---|
| Tensile strain on gross section of under plate | 25,150 |
| Tensile strain on net section of under plate | 43,580 |
| Compressive strain on bearing surface of rivets | 29,740 |
| Shearing strain on rivets | 22,990 |

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## No. 733.—$\frac{5}{8}$″ Iron Plate. Set C . .

Same style of joint as No. 732.
Upper plate, 10″.50 × ″.613.
Under plate, 10″.50 × ″.604.
1″ iron rivets, hand-driven.
Punched holes: Punch, $1\frac{1}{16}$″ diameter; die, $1\frac{5}{32}$″ diameter.

| | Square inches. |
|---|---|
| Gross sectional area of under plate | 6.34 |
| Net sectional area of under plate | 3.66 |
| Bearing surface of rivets | 5.36 |
| Shearing area of rivets | 7.09 |

| Loads applied. | Elongation in 10 inches. | Permanent set. | Remarks. |
|---|---|---|---|
| *Pounds.* | *Inch.* | *Inch.* | |
| 5,000 | 0. | | |
| 10,000 | .0006 | | |
| 20,000 | .0018 | | |
| 30,000 | .0030 | | |
| 40,000 | .0048 | | |
| 50,000 | .0075 | | |
| 55,000 | .0098 | | |
| 60,000 | .0113 | | |
| 65,000 | .0140 | | |
| 70,000 | .0168 | | |
| 80,000 | .0225 | | |
| 90,000 | .0298 | | |
| 100,000 | .0375 | | |
| 110,000 | .0470 | | |
| 120,000 | .06 | | |
| 130,000 | .07 | | |
| 140,000 | .08 | | |
| 150,000 | .10 | | |
| 160,000 | .14 | | |
| 167,800 | | | Ultimate strength. |

Fractured under plate across line of rivet holes.

*Maximum loads on joint.*

| | Pounds per sq. inch. |
|---|---|
| Tensile strain on gross section of under plate | 26,470 |
| Tensile strain on net section of under plate | 45,850 |
| Compressive strain on bearing surface of rivets | 31,310 |
| Shearing strain on rivets | 23,670 |

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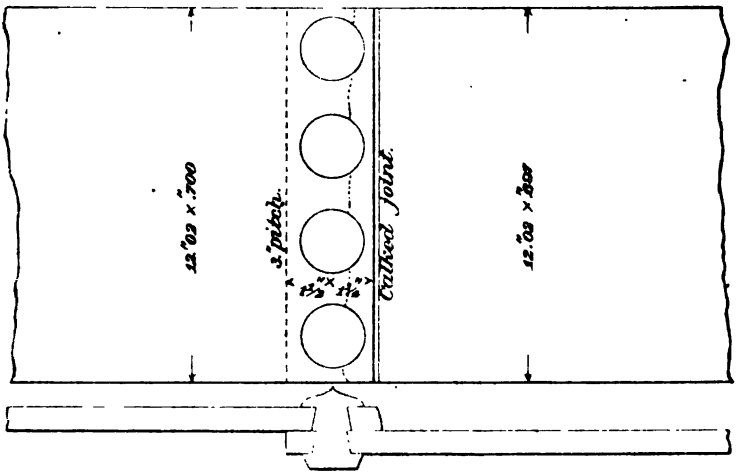
SINGLE AND DOUBLE RIVETED LAP JOINTS, ¼" IRON PLATE.

## No. 722.—¾" Iron Plate. Set A.




1⅛" iron rivets, hand-driven.
Punched holes: Punch, 1 3/16" diameter; die, 1 3/8" diameter.

| | Square inches. |
|---|---|
| Gross sectional area of under plate | 8.38 |
| Net sectional area of under plate | 4.93 |
| Bearing surface of rivets | 3.44 |
| Shearing area of rivets | 4.43 |

| Loads applied. | Elongation in 10 inches. | Permanent set. | Remarks. |
|---|---|---|---|
| *Pounds.* | *Inch.* | *Inch.* | |
| 5,000 | 0. | | |
| 10,000 | .0002 | | |
| 20,000 | .0010 | | |
| 30,000 | .0020 | | |
| 40,000 | .0032 | | |
| 50,000 | .0065 | | |
| 55,000 | .0088 | | |
| 60,000 | .0111 | | |
| 65,000 | .0141 | | |
| 70,000 | .0168 | | |
| 75,000 | .0195 | | |
| 80,000 | .0230 | | |
| 85,000 | .0400 | | Joint opened perceptibly. |
| 90,000 | .0480 | | |
| 100,000 | .07 | | |
| 110,000 | .10 | | Joint open ".03. |
| 120,000 | .14 | | |
| 130,000 | .19 | | |
| 140,000 | .29 | | |
| 144,400 | | | Ultimate strength. |

**Fractured the under plate across line of rivet holes.**

*Maximum loads on joint.*

| | Pounds per sq. inch. |
|---|---|
| Tensile strain on gross section of under plate | 17,230 |
| Tensile strain on net section of under plate | 29,290 |
| Compressive strain on bearing surface of rivets | 41,980 |
| Shearing strain on rivets | 32,600 |

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## No. 723.—$\frac{3}{4}$″ IRON PLATE. SET A . .

Duplicate of A . No. 722.
Upper plate, 12″.02 × ″.699.
Under plate, 12″.02 × ″.697.
$1\frac{1}{8}$″ iron rivets, hand-driven.
Punched holes: Punch, $1\frac{3}{16}$″ diameter; die, $1\frac{9}{32}$″ diameter.

| | Square inches. |
|---|---|
| Gross sectional area of under plate | 8.38 |
| Net sectional area of under plate | 4.93 |
| Bearing surface of rivets | 8.44 |
| Shearing area of rivets | 4.43 |

| Loads applied. | Elongation in 10 inches. | Permanent set. | Remarks. |
|---|---|---|---|
| *Pounds.* | *Inch.* | *Inch.* | |
| 5,000 | 0. | | |
| 10,000 | .0002 | | |
| 20,000 | .0008 | | |
| 30,000 | .0012 | | |
| 40,000 | .0021 | | |
| 45,000 | .0028 | | |
| 50,000 | .0041 | | |
| 55,000 | .0061 | | |
| 60,000 | .0085 | | |
| 65,000 | .0120 | | |
| 70,000 | .0148 | | |
| 75,000 | .0183 | | |
| 80,000 | .0210 | | |
| 85,000 | .0271 | | |
| 90,000 | .0370 | | |
| 95,000 | .0500 | | |
| 100,000 | .062 | | |
| 110,000 | .07 | | |
| 120,000 | .08 | | |
| 125,000 | | | Sharp sound heard. |
| 130,000 | .16 | | |
| 140,000 | .21 | | |
| 150,000 | .33 | | |
| 151,500 | | | Ultimate strength. |

Fractured the under plate across line of rivet holes.
Snapping sounds heard at intervals after load on joint reached 125,000 pounds.

*Maximum loads on joint.*

| | Pounds per sq. inch. |
|---|---|
| Tensile strain on gross section of under plate | 18,080 |
| Tensile strain on net section of under plate | 30,730 |
| Compressive strain on bearing surface of rivets | 44,040 |
| Shearing strain on rivets | 34,200 |

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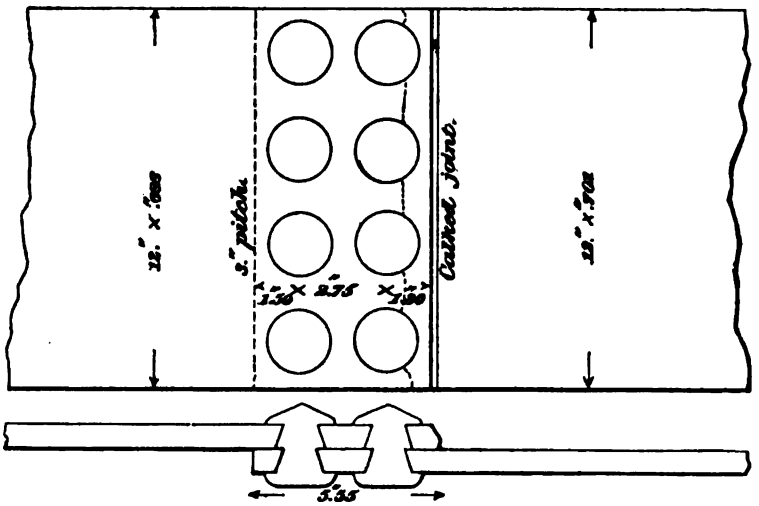
## No. 724.—$\frac{3}{4}$″ IRON PLATE. SET C.




$1\frac{1}{8}$″ iron rivets, hand-driven.
Punched holes: Punch, $1\frac{3}{16}$″ diameter; die, $1\frac{9}{32}$″ diameter.

| | Square inches. |
|---|---|
| Gross sectional area of under plate | 8.41 |
| Net sectional area of under plate | 4.95 |
| Bearing surface of rivets | 6.92 |
| Shearing area of rivets | 8.86 |

| Loads applied. | Elongation in 10 inches. | Permanent set. | Remarks. |
|---|---|---|---|
| *Pounds.* | *Inch.* | *Inch.* | |
| 5,000 | 0. | | |
| 10,000 | .0002 | | |
| 20,000 | .0009 | | |
| 30,000 | .0018 | | |
| 40,000 | .0030 | | |
| 50,000 | .0045 | | |
| 60,000 | .0068 | | |
| 70,000 | .0098 | | |
| 80,000 | .0145 | | |
| 85,000 | .0160 | | |
| 90,000 | .0190 | | |
| 95,000 | .0230 | | |
| 100,000 | .0255 | | Sharp snapping sounds heard. |
| 105,000 | .0289 | | |
| 110.000 | .0320 | | |
| 120,000 | .03+ | | Joint open ".02. |
| 130,000 | .04 | | |
| 140,000 | .05 | | |
| 150,000 | .06 | | |
| 162,000 | .07 | | |
| 170,000 | .10 | | |
| 180,000 | .13 | | |
| 200,000 | .23 | | |
| 207,900 | | | Ultimate strength. |

Fractured under plate across line of rivet holes.
After test upper plate found bent to an angle of 10°.



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*Maximum loads on joint.*

| | Pounds per sq. inch. |
|---|---|
| Tensile strain on gross section of under plate | 24,720 |
| Tensile strain on net section of under plate | 42,000 |
| Compressive strain on bearing surface of rivets | 30,040 |
| Shearing strain on rivets | 23,460 |

## No. 725.—$\frac{3}{4}$″ IRON PLATE. SET C . .

Duplicate of C . No. 724.
Upper plate, 12″ × ″.393.
Under plate, 12″ × ″.681.
$1\frac{1}{8}$″ iron rivets, hand-driven.
Punched holes: Punch, ″$1\frac{3}{16}$ diameter; die, ″$1\frac{9}{32}$ diameter.

| | Square inches. |
|---|---|
| Gross sectional area of under plate | 8.17 |
| Net sectional area of under plate | 4.81 |
| Bearing surface of rivets | 6.72 |
| Shearing area of rivets | 8.86 |

| Loads applied. | Elongation in 10 inches. | Permanent set. | Remarks. |
|---|---|---|---|
| *Pounds.* | *Inch.* | *Inch.* | |
| 5,000 | 0. | | |
| 10,000 | .0001 | | |
| 20,000 | .0008 | | |
| 30,000 | .0012 | | |
| 40,000 | .0020 | | |
| 50,000 | .0030 | | |
| 60,000 | .0050 | | |
| 70,000 | .0068 | | |
| 80,000 | .0092 | | |
| 90,000 | .0135 | | |
| 95,000 | .0160 | | |
| 100,000 | .0185 | | |
| 105,000 | .0210 | | |
| 110,000 | .0240 | | |
| 120,000 | .0308 | | Snapping sounds heard. |
| 130,000 | .0380 | | |
| 140,000 | .0465 | | |
| 150,000 | .0575 | | |
| 160,000 | .07 | | |
| 170,000 | .09 | | |
| 180,000 | .11 | | |
| 190,000 | .15 | | |
| 200,000 | .18 | | |
| 210,000 | .22 | | |
| 211,400 | | | Ultimate strength. |

Fractured under plate across line of rivet holes.

*Maximum loads on joint.*

| | Pounds per sq inch. |
|---|---|
| Tensile strain on gross section of under plate | 25,870 |
| Tensile strain on net section of under plate | 43,950 |
| Compressive strain on bearing surface of rivets | 31,460 |
| Shearing strain on rivets | 23,860 |

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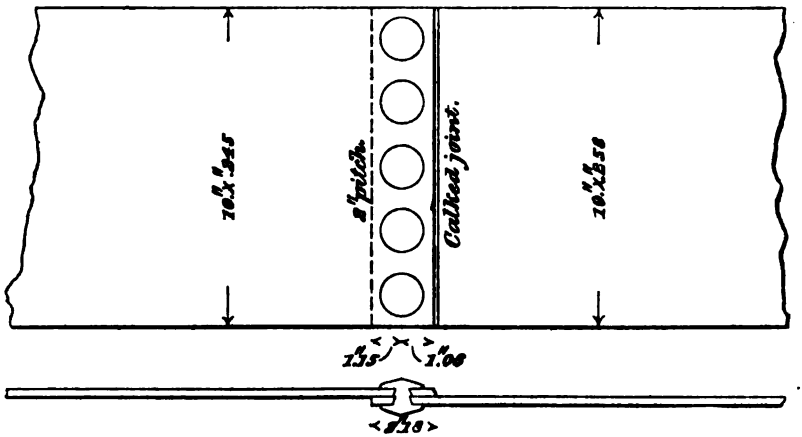
SINGLE-RIVETED LAP JOINTS, ¼″ STEEL PLATE.

## No. 426.—¼″ Steel Plate. Joint A.




⅝″ iron rivets, "Burden's best," machine-driven.
Punched holes: Punch, ".695 diameter; die, ".752 diameter.

| | Square inches |
|---|---|
| Gross sectional area of upper plate | 2.45 |
| Net sectional area of upper plate | 1.57 |
| Bearing surface of rivets | .882 |
| Shearing area of rivets (".70 diameter) | 1.92 |

| Loads applied. | Elongation in 10 inches. | Permanent set. | Remarks. |
|---|---|---|---|
| *Pounds.* | *Inch.* | *Inch.* | |
| 5,000 | 0. | | |
| 8,000 | .0004 | | |
| 10,000 | .0011 | | |
| 15,000 | .0022 | | |
| 20,000 | .0035 | | |
| 5,000 | | .0002 | |
| 25,000 | .0051 | | |
| 30,000 | .0067 | | |
| 35,000 | .0090 | | |
| 5,000 | | .0031 | |
| 38,000 | .0108 | | |
| 40,000 | .0122 | | |
| 42,000 | .0136 | | |
| 44,000 | .0152 | | |
| 46,000 | .0171 | | |
| 48,000 | .0198 | | |
| 50,000 | .0234 | | Calking shows decided movement of plates; also plates slightly bent. |
| 5,000 | | .0125 | |
| 52,000 | .0310 | | |
| 54,000 | .0365 | | Continued bending of plates. |
| 56,000 | .0434 | | Scale starts off upper plate along a line just touching rivet heads. |
| 58,000 | .0491 | | |
| 60,000 | .0578 | | |
| 5,000 | | .0432 | |
| 62,000 | .0661 | | |
| 64,000 | .0758 | | Calking opened about ".06. |
| 66,000 | .0911 | | |
| 68,000 | .1102 | | |
| 70,000 | .1362 | | |
| 72,000 | .1790 | | |
| 72,750 | .2260 | | Ultimate strength. |

Sheared the rivets; all rivets appeared to shear at same time. Fractured slightly two rivets under upper heads. Fractured all the rivets

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under the lower heads. No fractures started in the steel plates. Average elongation of holes in the plate, ".07.

*Maximum loads on joint.*

| | Pounds per sq. inch. |
|---|---|
| Tensile strain on gross section of upper plate | 29,690 |
| Tensile strain on net section of upper plate | 46,340 |
| Compressive strain on bearing surface of rivets | 82,480 |
| Shearing strain on rivets | 37,890 |

## No. 427.—¼" Steel Plate. Joint A . .

Same style of joint as No. 426.
Upper plate, 10"×".247.
Under plate, 10"×".247.
⅝" iron rivets, "Burden's best," machine-driven.
Punched holes: Punch, ".695 diameter; die, ".752 diameter.

| | Square inches. |
|---|---|
| Gross sectional area of plate | 2.47 |
| Net sectional area of plate | 1.58 |
| Bearing surface of rivets | .889 |
| Shearing area of rivets (".70 diameter) | 1.92 |

| Loads applied. | Elongation in 10 inches. | Permanent set. | Remarks. |
|---|---|---|---|
| *Pounds.* | *Inch.* | *Inch.* | |
| 5,000 | 0. | | |
| 8,000 | 0. | | |
| 10,000 | 0. | | |
| 15,000 | .0001 | | |
| 20,000 | .0008 | | |
| 5,000 | | .0009 | |
| 5,000 | 0. | | New gaugings began. |
| 20,000 | .0002 | | |
| 25,000 | .0010 | | |
| 30,000 | .0023 | | |
| 35,000 | .0040 | | |
| 5,000 | | .0020 | |
| 38,000 | .0052 | | |
| 40,000 | .0063 | | |
| 42,000 | .0075 | | |
| 44,000 | .0089 | | |
| 46,000 | .0099 | | |
| 48,000 | .0112 | | |
| 50,000 | .0159 | | |
| 5,000 | | .0090 | |
| 52,000 | .0210 | | |
| 54,000 | .0258 | | |
| 56,000 | .0312 | | |
| 58,000 | .0370 | | |
| 60,000 | .0452 | | |
| 5,000 | | .0352 | Calked joint opened about ".03. |
| 62,000 | .0540 | | Scale has started on two rivet heads. |
| 64,000 | .0620 | | |
| 66,000 | .0760 | | |
| 68,000 | .0890 | | |
| 70,000 | .1070 | | |
| 72,700 | .1660 | | Ultimate strength. Sheared rivets. |

After the ultimate load was passed and the pressure running down gradually the rivets sheared not simultaneously, as appeared to be the case with A . , but one rivet snapped first, quickly followed by the second and third; the two remaining rivets sounded as one when they parted.

*Maximum loads on joints.*

| | Pounds per sq. inch. |
|---|---|
| Tensile strain on gross section of plate | 29,430 |
| Tensile strain on net section of plate | 46,010 |
| Compressive strain on bearing surface of rivets | 81,780 |
| Shearing strain on rivets | 37,860 |

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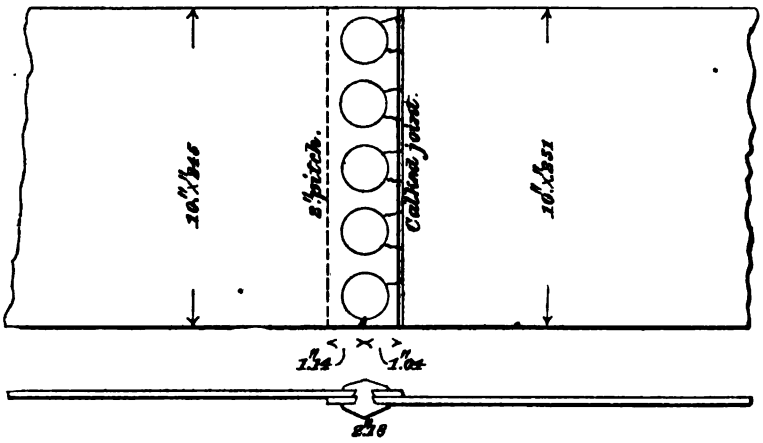
## No. 436.—¼″ Steel Plate. Joint A A.




⅝″ steel rivets, machine driven.
Punched holes: Punch, ".69 diameter; die, ".75 diameter.

| | Square inches. |
|---|---|
| Gross sectional area of plate | 2.45 |
| Net sectional area of plate | 1.57 |
| Bearing surface of rivets | .882 |
| Shearing area of rivets (".70 diameter) | 1.92 |

| Loads applied. | Elongation in 10 inches. | Permanent set. | Remarks. |
|---|---|---|---|
| *Pounds.* | *Inch.* | *Inch.* | |
| 5,000 | ..... | ..... | The joint was not calked tight; slightly open at the commencement of the test. |
| 10,000 | .0007 | ..... | |
| 15,000 | .0017 | ..... | |
| 20,000 | .0031 | ..... | |
| 25,000 | .0044 | ..... | |
| 30,000 | .0067 | ..... | |
| 35,000 | .0092 | ..... | |
| 5,000 | ..... | .0030 | |
| 38,000 | .0108 | ..... | |
| 40,000 | .0118 | ..... | |
| 42,000 | .0130 | ..... | |
| 44,000 | .0142 | ..... | |
| 46,000 | .0158 | ..... | |
| 48,000 | .0171 | ..... | |
| 50,000 | .0187 | ..... | Slight change in calking of joint is perceptible. |
| 5,000 | ..... | .0077 | |
| 52,000 | .0207 | ..... | |
| 54,000 | .0237 | ..... | |
| 56,000 | .0263 | ..... | |
| 58,000 | .0300 | ..... | |
| 60,000 | .0332 | ..... | Joint opened about ".03. |
| 62,000 | .0362 | ..... | |
| 64,000 | .0411 | ..... | |
| 66,000 | .0452 | ..... | Joint opened about ".05. |
| 68,000 | .0521 | ..... | |
| 70,000 | .0614 | ..... | |
| 72,000 | .0690 | ..... | |
| 74,000 | .0792 | ..... | |
| 76,000 | .0882 | ..... | |
| 78,000 | .1070 | ..... | |
| 80,000 | .123 | ..... | |
| 94,600 | ..... | ..... | Ultimate strength. |

Ultimate failure occurred by shearing the upper plate through the metal, as shown by the lines in the sketch. The first fracture which

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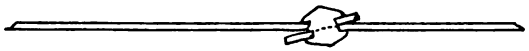
appeared in sight was at the end section at *A*. Holes in the under plate elongated about $\frac{3}{16}$" each.

Appearance of fractures: Silvery scale not disturbed on the body of the specimen.

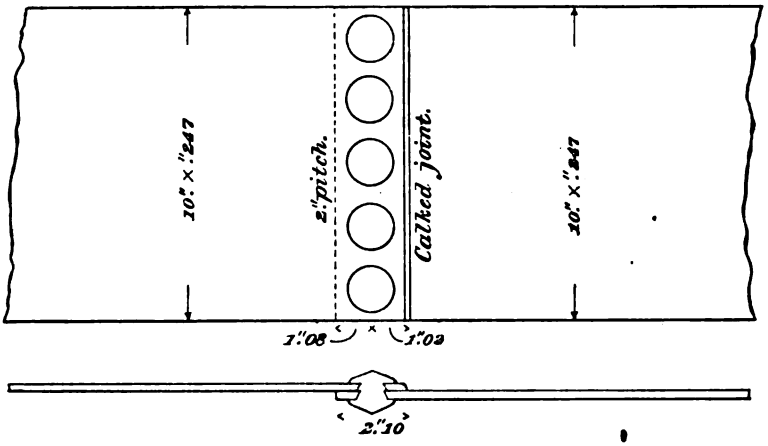
Lap ends of plate bent about 12°.

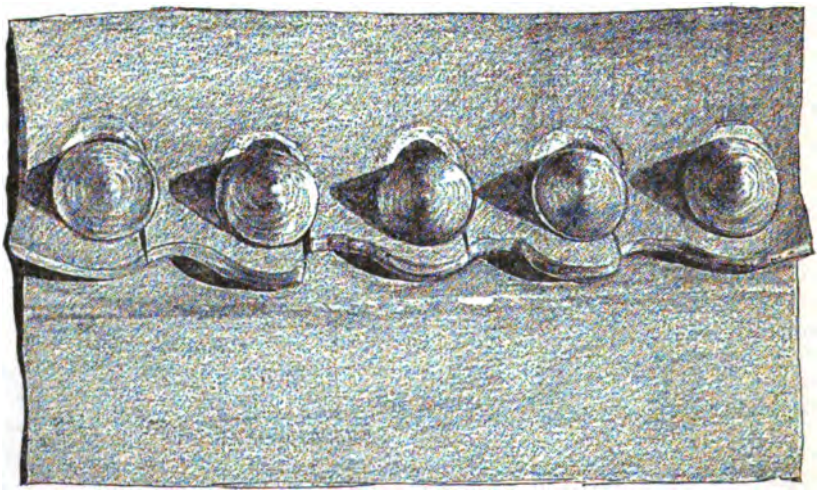


*Maximum loads on joint.*

| | Pounds per sq. inch. |
|---|---|
| Tensile strain on gross section of plate | 38,610 |
| Tensile strain on net section of plate | 60,250 |
| Compressive strain on bearing surface of rivets | 107,260 |
| Shearing strain on rivets | 49,270 |

## No. 437.—$\frac{1}{4}$" Steel Plate. Joint A A . .



$\frac{5}{8}$" steel rivets.

Punched holes: Punch, ".69 diameter; die, ".75 diameter.

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| | Square inches. |
|---|---|
| Gross sectional area of plate | 2.47 |
| Net sectional area of plate | 1.58 |
| Bearing surface of rivets | .889 |
| Shearing area of rivets (".70 diameter) | 1.92 |

| Loads applied. | Elongation in 10 inches. | Permanent set. | Remarks. |
|---|---|---|---|
| *Pounds.* | *Inch.* | *Inch.* | |
| 5,000 | | | |
| 10,000 | .0010 | | |
| 15,000 | .0025 | | |
| 20,000 | .0040 | | |
| 25,000 | .0061 | | |
| 30,000 | .0082 | | |
| 35,000 | .0108 | | |
| 5,000 | | .0085 | |
| 38,000 | .0130 | | Calking opened slightly in places. |
| 40,000 | .0130 | | |
| 42,000 | .0140 | | |
| 44,000 | .0150 | | Joint opened ".01. |
| 46,000 | .0165 | | |
| 48,000 | .0178 | | |
| 50,000 | .0191 | | Joint open about ".02. |
| 52,000 | .0211 | | |
| 54,000 | .0235 | | |
| 56,000 | .0260 | | |
| 58,000 | .0295 | | |
| 60,000 | .0329 | | Joint open ".03. |
| 62,000 | .0360 | | |
| 64,000 | .0402 | | Scale started on rivet heads. |
| 66,000 | .0445 | | |
| 68,000 | .0518 | | Joint open ".04. |
| 70,000 | .0599 | | |
| 74,000 | .0755 | | |
| 78,000 | .0950 | | |
| 80,000 | .1095 | | |
| 90,000 | .2470 | | |
| 98,600 | .3770 | | Ultimate strength. |

Joint failed similar to A A . by shearing plate, fractures beginning at the rivet holes.

Test discontinued before the fractures were all developed, the first fracture appearing at the second rivet from side of plate.

*Maximum loads on joint.*

| | Pounds per sq. inch. |
|---|---|
| Tensile strain on gross section of plate | 37,895 |
| Tensile strain on net section of plate | 59,240 |
| Compressive strain on bearing surface of rivets | 105,290 |
| Shearing strain on rivets | 48,750 |

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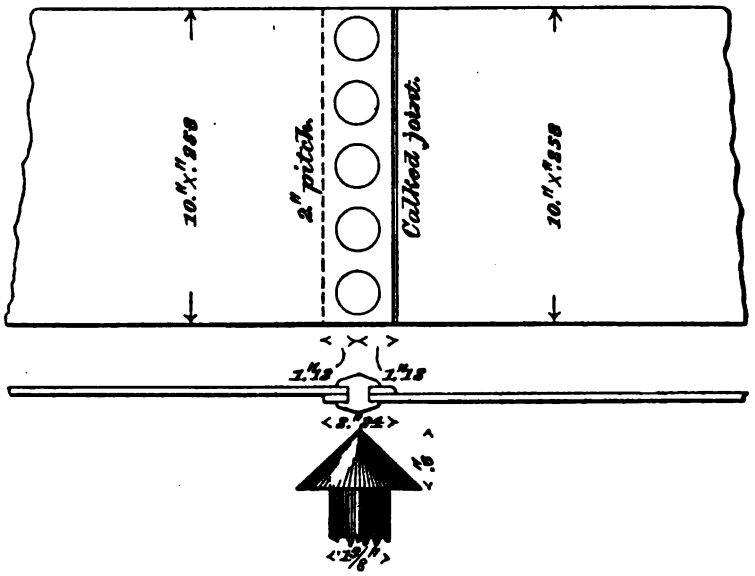
## No. 428.—¼″ Steel Plate. Joint C.




⅝″ iron rivets, "Burden's best," machine-drawn.
Drilled holes, ″.69 diameter.

| | Square inches. |
|---|---|
| Gross sectional area of plate | 2.53 |
| Net sectional area of plate | 1.66 |
| Bearing surface of rivets | .873 |
| Shearing area of rivets (″.69 diameter) | 1.87 |

| Loads applied. | Elongation in 10 inches. | Permanent set. | Remarks. |
|---|---|---|---|
| *Pounds.* | *Inch.* | *Inch.* | |
| 5,000 | 0. | | |
| 8,000 | .0006 | | |
| 10,000 | .0010 | | |
| 15,000 | .0020 | | |
| 20,000 | .0040 | | |
| 5,000 | | .0006 | |
| 25,000 | .0057 | | |
| 30,000 | .0089 | | |
| 32,000 | .0097 | | |
| 34,000 | .0103 | | |
| 35,000 | .0109 | | |
| 5,000 | | .0031 | |
| 36,000 | .0113 | | |
| 38,000 | .0122 | | |
| 40,000 | .0136 | | Scale started on two rivet heads; calking opened slightly. |
| 42,000 | .0149 | | |
| 44,000 | .0161 | | |
| 46,000 | .0179 | | |
| 48,000 | .0223 | | Calked joint opened about ″.02. |
| 50,000 | .0299 | | |
| 5,000 | | .0161 | |
| 52,000 | .0361 | | |
| 54,000 | .0430 | | |
| 56,000 | .0520 | | |
| 58,000 | .0620 | | |
| 60,000 | .0730 | | |
| 62,000 | .0910 | | |
| 64,000 | .1070 | | |
| 66,000 | .1330 | | |
| 67,980 | .2099 | | Ultimate strength. |

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Joint failed by shearing rivets and tearing off rivet heads.
Elongation of holes after fracture about ".07.

REMARKS.—The form of the rivet heads appears to be such as to develop weakness under the heads; the conical head being weak and easily bent at the edge, brings a strain tending to tear off the head, which is illustrated by the failure specimens A . A . . and C .

*Maximum loads on joint.*

| | Pounds per sq. inch. |
|---|---|
| Tensile strain on gross section of plate | 26,870 |
| Tensile strain on net section of plate | 40,950 |
| Compressive strain on bearing surface of rivets | 77,870 |
| Shearing strain on rivets | 36,350 |

## No. 429.—¼" STEEL PLATE. JOINT C . .

Same style of joint as No. 428.
Upper plate, 10" × ".248.
Under plate, 10" × ".248.
⅝" iron rivets, "Burden's best," machine-drawn.
Drilled holes, ".69 diameter.

| | Square inches. |
|---|---|
| Gross sectional area of plate | 2.48 |
| Net sectional area of plate | 1.62 |
| Bearing surface of rivets | .856 |
| Shearing area of rivets (".69 diameter) | 1.87 |

| Loads applied. | Elongation in 10 inches. | Permanent set. | Remarks. |
|---|---|---|---|
| *Pounds.* | *Inch.* | *Inch.* | |
| 5,000 | | | |
| 8,000 | .0008 | | |
| 10,000 | .0015 | | |
| 15,000 | .0027 | | |
| 20,000 | .0045 | | |
| 5,000 | | .0006 | |
| 25,000 | .0062 | | |
| 30,000 | .0087 | | |
| 35,000 | .0116 | | |
| 5,000 | | .0033 | |
| 38,000 | .0136 | | |
| 40,000 | .0155 | | |
| 42,000 | .0172 | | |
| 44,000 | .0195 | | |
| 46,000 | .0227 | | |
| 48,000 | .0276 | | |
| 50,000 | .0327 | | |
| 52,000 | .0390 | | |
| 54,000 | .0450 | | |
| 56,000 | .0530 | | |
| 58,000 | .0620 | | |
| 60,000 | .0720 | | |
| 68,650 | .1860 | | Ultimate strength. |

Failed by shearing the rivets.
Fractures started under rivet heads.

*Maximum loads on joint.*

| | Pounds per sq. inch |
|---|---|
| Tensile strain on gross section of plate | 27,680 |
| Tensile strain on net section of plate | 42,370 |
| Compressive strain on bearing surface of rivets | 80,200 |
| Shearing strain on rivets | 36,710 |

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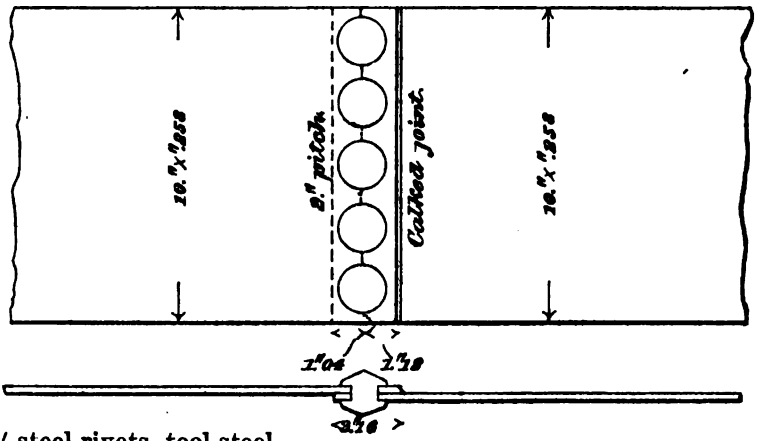
## No. 438.—¼″ Steel Plate. Joint C C




⅝″ steel rivets, tool-steel.
Drilled holes, ″.69 diameter.

| | Square inches. |
|---|---|
| Gross sectional area of plate | 2.53 |
| Net sectional area of plate | 1.66 |
| Bearing surface of rivets | .873 |
| Shearing area of rivets (″.69 diameter) | 1.87 |

| Loads applied. | Elongation in 10 inches. | Permanent set. | Remarks. |
|---|---|---|---|
| *Pounds.* | *Inch.* | *Inch.* | |
| 5,000 | | | |
| 10,000 | .0010 | | |
| 15,000 | .0020 | | |
| 20,000 | .0035 | | |
| 25,000 | .0049 | | |
| 30,000 | .0068 | | |
| 35,000 | .0091 | | |
| 5,000 | | .0040 | |
| 38,000 | .0110 | | Perceptible opening of joint. |
| 40,000 | .0120 | | |
| 42,000 | .0130 | | |
| 44,000 | .0145 | | |
| 46,000 | .0160 | | |
| 48,000 | .0170 | | Joint opened ″.01 |
| 50,000 | .0190 | | |
| 5,000 | | .0098 | |
| 52,000 | .0210 | | |
| 54,000 | .0230 | | |
| 56,000 | .0258 | | |
| 58,000 | .0290 | | Joint open ″.02. |
| 60,000 | .0320 | | |
| 62,000 | .0358 | | Joint open ″.03. |
| 64,000 | .0390 | | |
| 66,000 | .0430 | | Joint open ″.04. |
| 68,000 | .0475 | | |
| 70,000 | .0522 | | |
| 74,000 | .0640 | | Joint open ″.05. |
| 78,000 | .0800 | | |
| 86,000 | .0930 | | Joint open ″.06 to ″.07. |
| 90,000 | .1910 | | |
| 96,000 | .3270 | | |
| 104,900 | | | Ultimate strength. |

Tore under plate through line of rivets, fracture first making its appearance at second rivet hole. Before the ultimate strain was reached the under plate had stretched about the holes to such an extent that some of the holes were in sight beyond the rivet heads. After fracture the average elongation of holes in the fractured plate was ″.55. Fracture silky and the metal well drawn down. One rivet was weakened by the shearing strain.

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*Maximum loads on joint.*

| | Pounds per sq. inch. |
|---|---|
| Tensile strain on gross section of plate | 41,460 |
| Tensile strain on net section of plate | 63,190 |
| Compressive strain on bearing section of rivets | 120,160 |
| Shearing strain on rivets | 56,100 |

## No. 439.—¼″ Steel Plate. Joint C . C .

Same style of joint as No. 438.
Upper plate, 10″ × ″.248.
Under plate, 10″ × ″.245.
⅝″ steel rivets, tool-steel.
Drilled holes, ″.69 diameter.

| | Square inches. |
|---|---|
| Gross sectional area of plate | 2.45 |
| Net sectional area of plate | 1.60 |
| Bearing surface of rivets | .845 |
| Shearing area of rivets (″.69 diameter) | 1.87 |

| Loads applied. | Elongation in 10 inches. | Permanent set. | Remarks. |
|---|---|---|---|
| *Pounds.* | *Inch.* | *Inch.* | |
| 5,000 | | | |
| 10,000 | .0012 | | |
| 15,000 | .0022 | | |
| 20,000 | .0037 | | |
| 25,000 | .0052 | | |
| 30,000 | .0072 | | |
| 35,000 | .0101 | | |
| 5,000 | | .0032 | |
| 38,000 | .0114 | | |
| 40,000 | .0128 | | |
| 42,000 | .0142 | | Perceptible starting of the calked joint. |
| 45,000 | .0163 | | |
| 48,000 | .0192 | | |
| 50,000 | .0214 | | Joint opened about ″.00½. |
| 5,000 | | .0103 | Joint closes where strains are released. |
| 52,000 | .0242 | | Joint open ″.01. |
| 55,000 | .0300 | | |
| 58,000 | .0361 | | |
| 60,000 | .0402 | | |
| 62,000 | .0450 | | |
| 64,000 | .0492 | | |
| 66,000 | .0552 | | Joint open ″.05. |
| 68,000 | .0622 | | Joint open ″.06. |
| 70,000 | .0713 | | |
| 75,000 | .1002 | | |
| 80,000 | .1462 | | |
| 90,000 | .3510 | | |
| 98,100 | | | Ultimate strength. |

Fractured through the under plate same as C C. Before the ultimate load was reached the holes in the under plate had elongated so as to appear beyond the rivet heads. After fracture, average elongation of holes in fractured plate ″.53; metal well drawn down. Total width of steel reduced about ″.06, the joint ends puckered, presenting wavy lines. The holes in the upper plate elongated about ″.28 each. Opposite one rivet the metal began to fracture from the end of the plate. When final fracture occurred the metal gave way, first at the inside sections. The rivets were weakened and indented about ″.04 by the shearing strain.

*Maximum loads on joint.*

| | Pounds per sq. inch. |
|---|---|
| Tensile strain on gross section of plate | 40,040 |
| Tensile strain on net section of plate | 61,310 |
| Compressive strain on bearing surface of rivets | 116,090 |
| Shearing strain on rivet | 52,460 |

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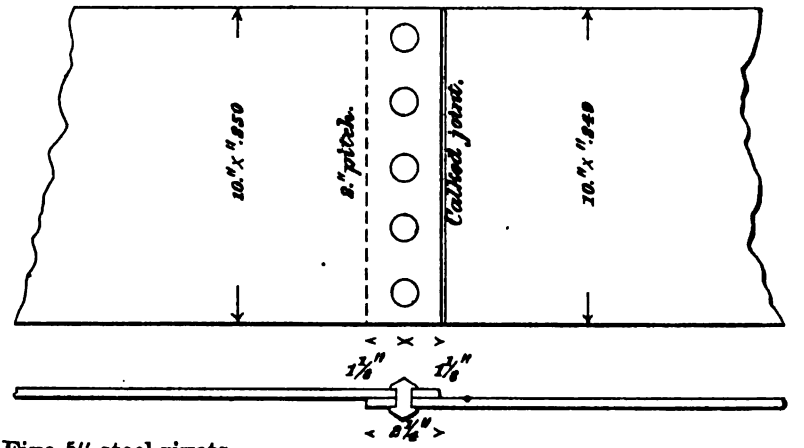
## No. 49.—¼″ Steel Plate. Joint C C C.




Five ⅝″ steel rivets.
Drilled holes, ″.69 diameter.

| | Square inches. |
|---|---|
| Gross sectional area of under plate | 2.49 |
| Net sectional area of under plate | 1.63 |
| Bearing surface of rivets | 8.56 |
| Shearing area of rivets | 1.57 |

| Loads applied. | Elongation in 10 inches. | Permanent set. | Remarks. |
|---|---|---|---|
| *Pounds.* | *Inch.* | *Inch.* | |
| 5,000 | 0. | | |
| 10,000 | .0005 | | |
| 15,000 | .0010 | | |
| 20,000 | .0020 | | |
| 25,000 | .0035 | | |
| 30,000 | .0050 | | |
| 35,000 | .0080 | | |
| 5,000 | | .0035 | |
| 40,000 | .0110 | | |
| 45,000 | .0143 | | |
| 50,000 | .0182 | | |
| 52,000 | .0198 | | |
| 54,000 | .0218 | | |
| 56,000 | .0245 | | |
| 58,000 | .0270 | | |
| 60,000 | .0306 | | |
| 62,000 | .0345 | | Joint started perceptibly. |
| 64,000 | .0465 | | Joint open ″.01. |
| 66,000 | .0530 | | |
| 68,000 | .0585 | | Joint open ″.03. |
| 70,000 | .0688 | | Joint open ″.04. |
| 72,000 | .0768 | | |
| 74,000 | .0870 | | Joint open ″.05. |
| 76,000 | .0960 | | |
| 78,000 | .1090 | | |
| 80,000 | .1218 | | |
| 98,100 | | | Ultimate strength. Sheared rivets. |

Average elongation of holes, ″.18.

*Maximum loads on joint.*

| | Pounds per sq. inch. |
|---|---|
| Tensile strain on gross section of plate | 39,400 |
| Tensile strain on net section of plate | 60,184 |
| Compressive strain on bearing surface of rivets | 114,603 |
| Shearing strain on rivets | 52,742 |

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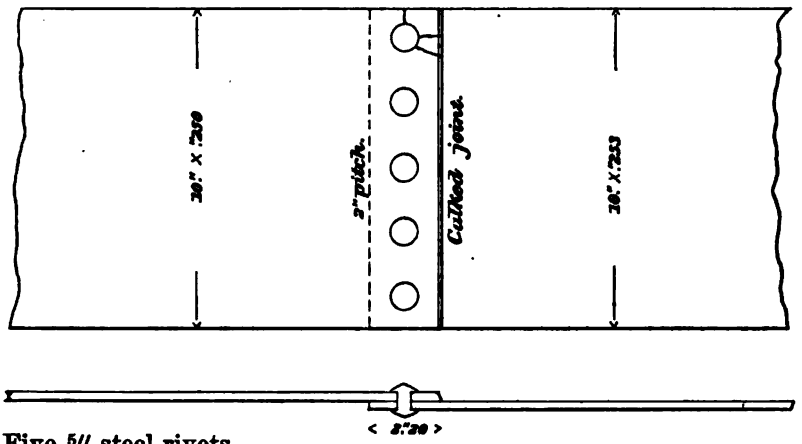
## No. 50.—¼″ Steel Plate. Joint CCC . .




Five ⅝″ steel rivets.
Drilled holes, ″.69 diameter.

| | Square inches. |
|---|---|
| Gross sectional area of upper plate | 2.50 |
| Net sectional area of upper plate | 1.64 |
| Bearing surface of rivets | .859 |
| Shearing area of rivets | 1.86 |

| Loads applied. | Elongation in 10 inches. | Permanent set. | Remarks. |
|---|---|---|---|
| *Pounds.* | *Inch.* | *Inch.* | |
| 5,000 | 0. | | |
| 10,000 | .0008 | | |
| 20,000 | .0030 | | |
| 30,000 | .0069 | | |
| 35,000 | .0090 | | |
| 5,000 | | .0040 | |
| 40,000 | .0125 | | |
| 45,000 | .0151 | | |
| 50,000 | .0188 | | |
| 52,000 | .0210 | | |
| 54,000 | .0235 | | Joint started perceptibly. |
| 56,000 | .0280 | | |
| 58,000 | .0350 | | Joint open ″.01. |
| 60,000 | .0395 | | |
| 62,000 | .0452 | | |
| 64,000 | .0508 | | Joint open ″.02. |
| 66,000 | .0568 | | |
| 68,000 | .0640 | | Joint open ″.03. |
| 70,000 | .0710 | | |
| 72,000 | .0790 | | Joint open ″.04. |
| 74,000 | .0880 | | |
| 76,000 | .0988 | | |
| 78,000 | .1112 | | Joint open ″.05. |
| 80,000 | .1275 | | |
| 94,200 | | | Ultimate strength. Sheared four rivets. Tore out plate at end rivet. |

Elongation of inside holes, ″.12 each.
Elongation of end hole, ″.26.

*Maximum loads on joint.*

| | Pounds per sq. inch. |
|---|---|
| Tensile strain on gross section of plate | 37,680 |
| Tensile strain on net section of plate | 57,439 |
| Compressive strain on bearing surface of rivets | 109,650 |
| Shearing strain on rivets | 50,645 |

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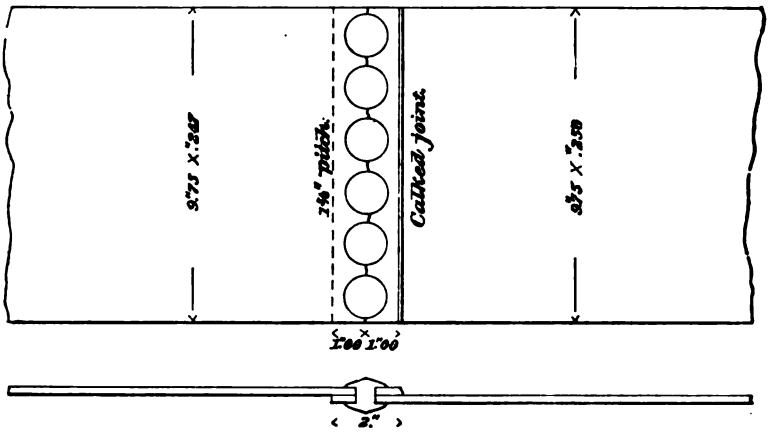
## No. 430.—¼″ Steel Plate. Joint E.




⅝″ steel rivets.
Drilled holes, ″.69 diameter.

| | Square inches. |
|---|---|
| Gross sectional area of plate | 2.44 |
| Net sectional area of plate | 1.40 |
| Bearing surface of rivets | 1.04 |
| Shearing area of rivets (″.69 diameter) | 2.24 |

| Loads applied. | Elongation in 10 inches. | Permanent set. | Remarks. |
|---|---|---|---|
| *Pounds.* | *Inch.* | *Inch.* | |
| 5,000 | ..... | ..... | |
| 8,000 | .0007 | ..... | |
| 10,000 | .0013 | ..... | |
| 15,000 | .0030 | ..... | |
| 20,000 | .0045 | ..... | |
| 5,000 | ..... | .0010 | |
| 25,000 | .0064 | ..... | |
| 30,000 | .0085 | ..... | |
| 35,000 | .0110 | ..... | |
| 5,000 | ..... | .0033 | |
| 40,000 | .0135 | ..... | |
| 42,000 | .0147 | ..... | |
| 44,000 | .0160 | ..... | |
| 46,000 | .0173 | ..... | |
| 48,000 | .0187 | ..... | |
| 50,000 | .0205 | ..... | Calked joint slightly started. |
| 52,000 | .0228 | ..... | |
| 54,000 | .0245 | ..... | |
| 56,000 | .0265 | ..... | |
| 58,000 | .0295 | ..... | |
| 60,000 | .0321 | ..... | |
| 5,000 | ..... | .0173 | |
| 10,000 | .0012 | ..... | |
| 15,000 | .0022 | ..... | |
| 20,000 | .0037 | ..... | |
| 25,000 | .0052 | ..... | |
| 30,000 | .0067 | ..... | |
| 35,000 | .0067 | ..... | |
| 40,000 | .0082 | ..... | |
| 50,000 | .0110 | ..... | |
| 60,000 | .0142 | ..... | |
| 62,000 | .0332 | ..... | |
| 64,000 | .0364 | ..... | |
| 66,000 | .0395 | ..... | |
| 68,000 | .0431 | ..... | |
| 70,000 | .0460 | ..... | |
| 72,000 | .0500 | ..... | |
| 74,000 | .0540 | ..... | |
| 76,000 | .0595 | ..... | |
| 78,000 | .0681 | ..... | |
| 80,000 | .0745 | ..... | |
| 82,000 | .0833 | ..... | |
| 84,000 | .0947 | ..... | |
| 93,600 | ..... | ..... | Ultimate strength. |

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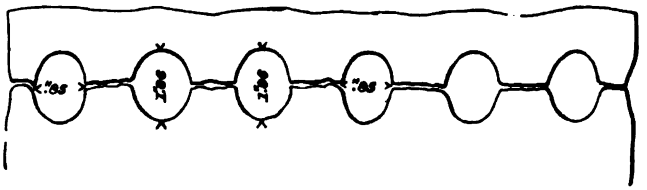
Failed by fracturing the under plate through rivet holes.
Silky fractures slightly lamellar, metal well drawn down.
Scale started on rivet heads; otherwise they appear undisturbed.
After the test the rivets were loose in the plate not fractured.
Fracture began at one edge and in first section between rivets.

*Maximum loads on joint.*

| | Pounds per sq. inch. |
|---|---|
| Tensile strain on gross section of lower plate | 38,360 |
| Tensile strain on net section of lower plate | 66,860 |
| Compressive strain on bearing surface of rivets | 90,000 |
| Shearing strain on rivets | |




Sketch, drawn one-third size, showing shape of rivet holes in fractured plate.

## No. 431.—¼″ Steel Plate. Joint E . .

Same style of joint as No. 430.
Upper plate, 9″.75 × ″.250.
Under plate, 9.″75 × .″250.
⅝″ steel rivets.
Drilled holes, ″.69 diameter.

| | Square inches. |
|---|---|
| Gross sectional area of plate | 2.44 |
| Net sectional area of plate | 1.40 |
| Bearing surface of rivets | 1.04 |
| Shearing area of rivets (″.69 diameter) | 2.24 |

| Loads applied. | Elongation in 10 inches. | Permanent set. | Remarks. |
|---|---|---|---|
| *Pounds.* | *Inch.* | *Inch.* | |
| 5,000 | ..... | ..... | |
| 10,000 | .0004 | ..... | |
| 15,000 | .0010 | ..... | |
| 20,000 | .0018 | ..... | |
| 25,000 | .0031 | ..... | |
| 30,000 | .0045 | ..... | |
| 35,000 | .0065 | ..... | |
| 5,000 | ..... | .0025 | |
| 40,000 | .0091 | ..... | |
| 42,000 | .0103 | ..... | |
| 44,000 | .0114 | ..... | |
| 46,000 | .0130 | ..... | |
| 48,000 | .0145 | ..... | |
| 50,000 | .0164 | ..... | |
| 52,000 | .0183 | ..... | |
| 54,000 | .0205 | ..... | |
| 56,000 | .0233 | ..... | |
| 58,000 | .0256 | ..... | |
| 60,000 | .0285 | ..... | |
| 5,000 | ..... | .0180 | Calked joint slipped but not opened. |
| 62,000 | .0311 | ..... | |
| 64,000 | .0343 | ..... | |
| 66,000 | .0374 | ..... | |
| 68,000 | .0405 | ..... | |
| 70,000 | .0447 | ..... | |
| 72,000 | .0493 | ..... | Rivet heads scale off. Joint is about ″.03 open. |
| 74,000 | .0525 | ..... | |
| 76,000 | .0583 | ..... | |
| 78,000 | .0673 | ..... | |
| 80,000 | .0860 | ..... | |
| 98,000 | ..... | ..... | Ultimate strength. |

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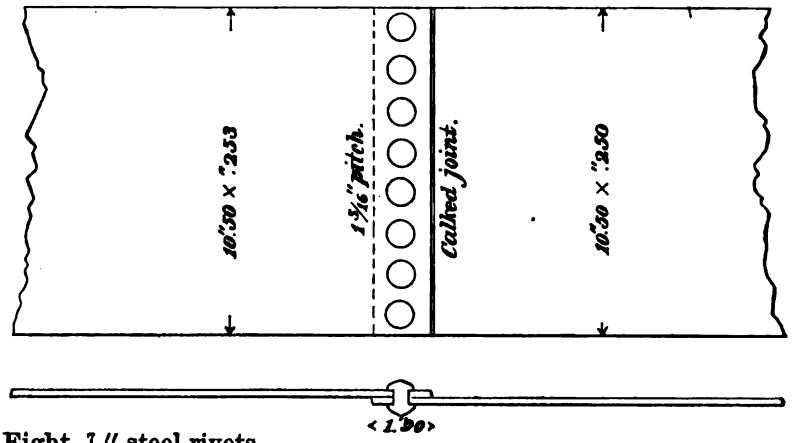
Fractured under plate through line of rivet holes same as E. The upper plate drew down in total width about ".10, causing the joint to pucker. Fine silky fractures, the metal well drawn down. Fracture began on one side, then reaching across the plate, beginning the fracture on the opposite side as it stood in the testing machine from the fracture of E.

*Maximum loads on joint.*

| | Pounds per sq. inch. |
|---|---|
| Tensile strain on gross section of plate | 40,160 |
| Tensile strain on net section of plate | 70,000 |
| Compressive strain on bearing surface of rivets | 34,230 |
| Shearing strain on rivets | |

## No. 47.—¼" Steel Plate. Joint H.




Eight $\frac{7}{16}$" steel rivets.
Drilled holes, ".50 diameter.

| | Square inches. |
|---|---|
| Gross sectional area of upper plate | 2.66 |
| Net sectional area of upper plate | 1.64 |
| Bearing surface of rivets | 1.01 |
| Shearing area of rivets | 1.572 |

| Loads applied. | Elongation in 10 inches. | Permanent set. | Remarks. |
|---|---|---|---|
| *Pounds.* | *Inch.* | *Inch.* | |
| 5,000 | 0. | | |
| 10,000 | .0008 | | |
| 15,000 | .0020 | | |
| 20,000 | .0028 | | |
| 30,000 | .0050 | | |
| 35,000 | .0070 | | |
| 5,000 | | .0025 | |
| 40,000 | .0095 | | |
| 42,000 | .0108 | | |
| 44,000 | .0120 | | |
| 46,000 | .0133 | | |
| 48,000 | .0150 | | |
| 50,000 | .0170 | | Scale starts on rivet heads. |
| 5,000 | | .0075 | |
| 52,000 | .0195 | | |
| 54,000 | .0220 | | |
| 56,000 | .0249 | | Joint started perceptibly. |
| 58,000 | .0270 | | |
| 60,000 | .0300 | | |

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| Loads applied. | Elongation in 10 inches. | Permanent set. | Remarks. |
|---|---|---|---|
| *Pounds.* | *Inch.* | *Inch.* | |
| 62,000 | .0320 | ..... | Joint open ".01. |
| 64,000 | .0350 | ..... | |
| 66,000 | .0380 | ..... | |
| 68,000 | .0420 | ..... | |
| 70,000 | .0461 | ..... | |
| 72,000 | .0500 | ..... | Joint open ".02. |
| 74,000 | .0549 | ..... | |
| 76,000 | .0590 | ..... | |
| 78,000 | .0652 | ..... | Joint open ".03. |
| 80,000 | .0695 | ..... | |
| 82,000 | .0758 | ..... | |
| 84,000 | .0830 | ..... | |
| 86,000 | .0890 | ..... | |
| 88,000 | .0972 | ..... | Joint open ".06. |
| 90,000 | .1072 | ..... | |
| 92,000 | .1250 | ..... | |
| 96,600 | ..... | ..... | Rapid stretching of plate. |
| 102,400 | ..... | ..... | Ultimate strength. Sheared rivets. |

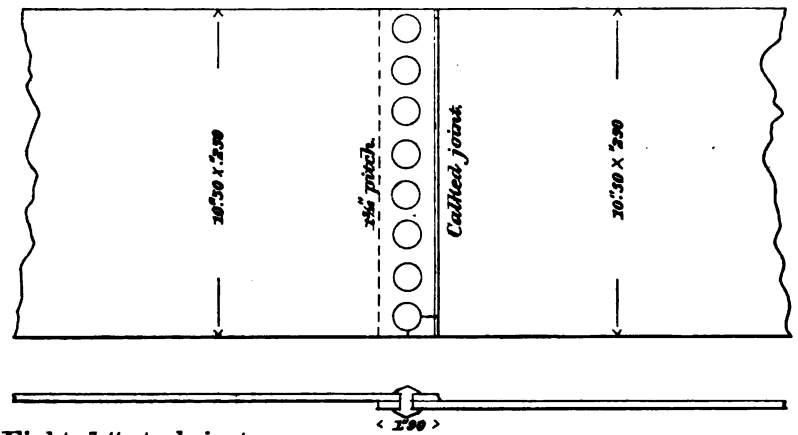
The inside of the upper plate showed very complete removal of scale. The outside of this plate the scale not removed partially. This behavior would naturally follow from the bending of the plate while under tensile stress, elongating the fibers on the convex side of the sheet more than the fibers on the concave side.

Average elongation of rivet holes, ".10.

*Maximum loads on joint.*

| | Pounds per sq. inch. |
|---|---|
| Tensile strain on gross section of upper plate | 38,496 |
| Tensile strain on net section of upper plate | 62,440 |
| Compressive strain on bearing surface of rivets | 101,180 |
| Shearing strain on rivets | 65,220 |

No. 48.—¼" Steel Plate. Joint H . .




Eight $\frac{7}{16}$" steel rivets.
Drilled holes, ".50 diameter.

| | Square inches. |
|---|---|
| Gross sectional area of plate | 2.625 |
| Net sectional area of plate | 1.625 |
| Bearing surface of rivets | 1.00 |
| Shearing area of rivets | 1.57 |



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| Loads applied. | Elongation in 10 inches. | Permanent set. | Remarks. |
|---|---|---|---|
| *Pounds.* | *Inch.* | *Inch.* | |
| 5,000 | 0. | ..... | |
| 10,000 | .0009 | ..... | |
| 20,000 | .0030 | ..... | |
| 30,000 | .0060 | ..... | |
| 35,000 | .0081 | ..... | |
| 5,000 | ..... | .0023 | |
| 40,000 | .0110 | ..... | |
| 45,000 | .0140 | ..... | |
| 48,000 | .0162 | ..... | |
| 50,000 | .0180 | ..... | |
| 52,000 | .0200 | ..... | Scale started on rivet heads. Joint started perceptibly. |
| 54,000 | .0228 | ..... | |
| 56,000 | .0248 | ..... | |
| 58,000 | .0272 | ..... | |
| 60,000 | .0300 | ..... | |
| 62,000 | .0320 | ..... | |
| 64,000 | .0350 | ..... | |
| 66,000 | .0378 | ..... | |
| 68,000 | .0400 | ..... | Joint open ".01. |
| 70,000 | .0440 | ..... | |
| 72,000 | .0478 | ..... | |
| 74,000 | .0521 | ..... | |
| 76,000 | .0565 | ..... | |
| 78,000 | .0610 | ..... | Joint open ".02. |
| 80,000 | .0670 | ..... | |
| 82,000 | .0722 | ..... | Joint open ".03. |
| 84,000 | .0790 | ..... | |
| 86,000 | .0860 | ..... | |
| 88,000 | .0935 | ..... | |
| 90,000 | .1040 | ..... | Joint open ".06. |
| 94,800 | ..... | ..... | Ultimate strength. Sheared seven rivets and tore out plate at end rivet. |

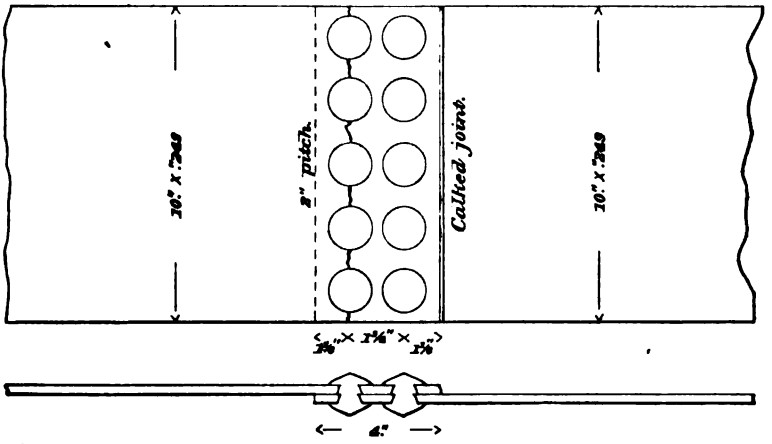
Average elongation of holes, ".07.

*Maximum loads on joint.*

| | Pounds per sq. inch. |
|---|---|
| Tensile strain on gross section of plate | 36,114 |
| Tensile strain on net section of plate | 58,338 |
| Compressive strain on bearing surface of rivets | 94,880 |
| Shearing strain on rivets | 60,382 |

DOUBLE-RIVETED LAP JOINTS, ¼" STEEL PLATE.

No. 432.—¼" STEEL PLATE. JOINT F.




⅝" iron rivets, "Burden's best."
Punched holes: Punch, ".695 diameter; die, ".752 diameter.

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| | Square inches. |
|---|---|
| Gross sectional area of plate | 2.49 |
| Net sectional area of plate | 1.59 |
| Bearing surface of rivets | 1.79 |
| Shearing area of rivets (".70 diameter) | 3.85 |

| Loads applied. | Elongation in 10 inches. | Permanent set. | Remarks. |
|---|---|---|---|
| *Pounds.* | *Inch.* | *Inch.* | |
| 5,000 | ..... | ..... | |
| 10,000 | .0012 | ..... | |
| 15,000 | .0026 | ..... | |
| 20,000 | .0041 | ..... | |
| 5,000 | ..... | .0009 | |
| 25,000 | .0055 | ..... | |
| 30,000 | .0071 | ..... | |
| 35,000 | .0089 | ..... | |
| 5,000 | ..... | .0028 | |
| 40,000 | .0110 | ..... | |
| 42,000 | .0118 | ..... | |
| 44,000 | .0125 | ..... | |
| 46,000 | .0133 | ..... | |
| 48,000 | .0142 | ..... | |
| 50,000 | ..... | ..... | Calked joint opened about ".01. |
| 52,000 | .0161 | ..... | |
| 54,000 | .0175 | ..... | |
| 56,000 | .0182 | ..... | |
| 58,000 | .0196 | ..... | |
| 60,000 | .0210 | ..... | |
| 5,000 | ..... | .0116 | |
| 62,000 | .0220 | ..... | |
| 64,000 | .0232 | ..... | |
| 66,000 | .0250 | ..... | Calked joint opened about ".03. |
| 68,000 | .0260 | ..... | |
| 70,000 | .0280 | ..... | |
| 72,000 | .0298 | ..... | |
| 74,000 | .0316 | ..... | |
| 76,000 | .0340 | ..... | |
| 78,000 | .0369 | ..... | |
| 80,000 | .0405 | ..... | Joint opened about ".04 to ".05. |
| 82,000 | .0440 | ..... | |
| 84,000 | .0500 | ..... | |
| 86,000 | .0610 | ..... | |
| 97,300 | ..... | ..... | Ultimate strength. |

Fractured upper plate through line of rivet holes. Fractures began at the rivet holes weakening the whole plate at the same time, the bent and marked edge apparently not effecting the manner of fracture Fractures fine silky; metal well drawn down. The fractured plate had the die-side in.

*Maximum loads on joint.*

| | Pounds per sq. inch. |
|---|---|
| Tensile strain on gross section of plate | 39,280 |
| Tensile strain on net section of plate | 61,510 |
| Compressive strain on bearing surface of rivets | 54,640 |
| Shearing strain on rivets | 25,400 |

## No. 433.—$\frac{1}{4}$" Steel Plate. Joint F . .

Same style of joint as No. 432.
Upper plate, 10" × ".248.
Under plate, 10" × ".254.
$\frac{5}{8}$" iron rivets, "Burden's best."
Punched holes: Punch, ".695 diameter; die, ".752 diameter.

| | Square inches. |
|---|---|
| Gross sectional area of plate | 2.54 |
| Net sectional area of plate | 1.63 |
| Bearing surface of rivets | 1.83 |
| Shearing area of rivets (".70 diameter) | 3.85 |

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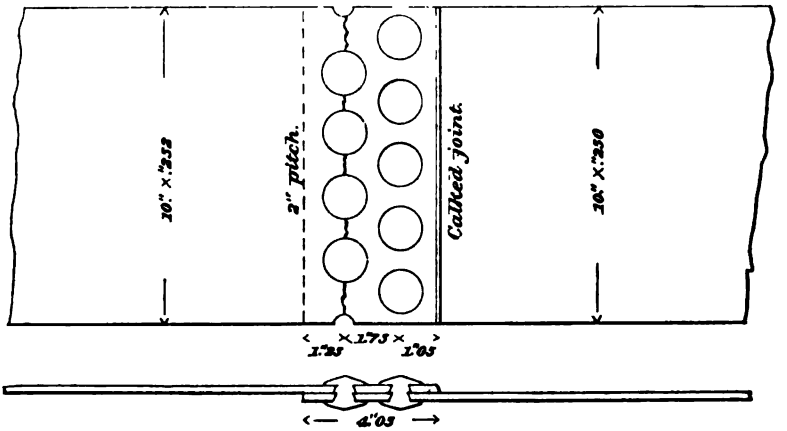
| Loads applied. | Elongation in 10 inches. | Permanent set. | Remarks. |
|---|---|---|---|
| *Pounds.* | *Inch.* | *Inch.* | |
| 5,000 | ..... | ..... | |
| 10,000 | .0018 | ..... | |
| 15,000 | .0026 | ..... | |
| 20,000 | .0038 | ..... | |
| 5,000 | ..... | .0008 | |
| 25,000 | .0048 | ..... | |
| 30,000 | .0063 | ..... | |
| 35,000 | .0079 | ..... | |
| 5,000 | ..... | .0018 | |
| 40,000 | .0098 | ..... | |
| 42,000 | .0100 | ..... | |
| 44,000 | .0108 | ..... | |
| 46,000 | .0118 | ..... | |
| 48,000 | .0126 | ..... | |
| 50,000 | .0131 | ..... | |
| 52,000 | .0138 | ..... | |
| 56,000 | .0158 | ..... | |
| 58,000 | .0168 | ..... | Calked joint opened about ".01. |
| 60,000 | .0179 | ..... | |
| 5,000 | ..... | .0070 | |
| 62,000 | .0198 | ..... | |
| 64,000 | .0207 | ..... | |
| 66,000 | .0218 | ..... | |
| 68,000 | .0238 | ..... | |
| 70,000 | .0257 | ..... | |
| 72,000 | .0268 | ..... | |
| 74,000 | .0290 | ..... | |
| 76,000 | .0318 | ..... | |
| 78,000 | .0343 | ..... | |
| 80,000 | .0374 | ..... | |
| 82,000 | .0408 | ..... | |
| 84,000 | .0456 | ..... | |
| 86,000 | .0517 | ..... | |
| 88,000 | .0630 | ..... | |
| 90,000 | .0750 | ..... | |
| 98,300 | ..... | ..... | Ultimate strength. |

Fractured lower plate across line of rivet holes; appearance of fracture, silky; metal well drawn down.

*Maximum loads on joint.*

| | Pounds per sq. inch. |
|---|---|
| Tensile strain on gross section of plate | 38,700 |
| Tensile strain on net section of plate | 60,300 |
| Compressive strain on bearing surface of rivets | 53,715 |
| Shearing strain on rivets | 25,530 |

## No. 434.—¼″ STEEL PLATE. JOINT G.




⅝″ iron rivets, "Burden's best."
Punched holes: Punch, ".695 diameter; die, .752 diameter.

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| | Square inches. |
|---|---|
| Gross sectional area of plate | 2.55 |
| Net sectional area of plate | 1.61 |
| Bearing surface of rivets | 1.63 |
| Shearing area of rivets (".70 diameter) | 3.46 |

| Loads applied. | Elongation in 10 inches. | Permanent set. | Remarks. |
|---|---|---|---|
| *Pounds.* | *Inch.* | *Inch.* | |
| 5,000 | | | |
| 10,000 | .0014 | | |
| 15,000 | .0027 | | |
| 20,000 | .0039 | | |
| 5,000 | | .0009 | |
| 25,000 | .0054 | | |
| 30,000 | .0071 | | |
| 35,000 | .0091 | | |
| 5,000 | | .0031 | |
| 40,000 | .0117 | | |
| 42,000 | .0127 | | |
| 44,000 | .0135 | | |
| 46,000 | .0149 | | |
| 48,000 | .0159 | | |
| 50,000 | .0168 | | |
| 52,000 | .0179 | | |
| 54,000 | .0190 | | |
| 56,000 | .0200 | | |
| 58,000 | .0214 | | |
| 60,000 | .0229 | | Joint opened about ".01 or less. |
| 5,000 | | .0109 | |
| 62,000 | .0240 | | |
| 64,000 | .0249 | | |
| 66,000 | .0264 | | |
| 68,000 | .0279 | | |
| 70,000 | .0298 | | |
| 72,000 | .0314 | | |
| 74,000 | .0338 | | |
| 76,000 | .0361 | | |
| 78,000 | .0404 | | |
| 80,000 | .0445 | | |
| 82,000 | .0505 | | |
| 84,000 | .0541 | | |
| 86,000 | .0634 | | |
| 88,000 | .0724 | | Joint opened about ".03. |
| 90,000 | .0890 | | |
| 105,300 | | | Ultimate strength. |

Fractured upper plate through line of four rivet holes. The fracture began at the holes.

Metal silky in appearance and well drawn down. After fracture the slip of the plates at the calked joint measured ".15. The joint was very greasy from oil used in punching.

*Maximum loads on joint.*

| | Pounds per sq. inch. |
|---|---|
| Tensile strain on gross section of plate | 41,785 |
| Tensile stain on net section of plate | 65,400 |
| Compressive strain on bearing surface of rivets | 64,600 |
| Shearing strain on rivets | 30,430 |

## No. 435.—¼" Steel Plate. Joint G . .

Same style of joint as No. 434.
Upper plate, 10" × ".254.
Under plate, 10" × ".254.
⅝" iron rivets, "Burden's best."
Punched holes: Punch, ".695 diameter; die, ".752 diameter.

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| | Square inches. |
|---|---|
| Gross sectional area of plate | 2.54 |
| Net sectional area of plate | 1.63 |
| Bearing surface of rivets | 1.66 |
| Shearing area of rivets (".70 diameter) | 3.46 |

Specimen warped on the side.

| Loads applied. | Elongation in 10 inches. | Permanent set. | Remarks. |
|---|---|---|---|
| *Pounds.* | *Inch.* | *Inch.* | |
| 5,000 | | | |
| 10,000 | .0008 | | |
| 15,000 | .0010 | | |
| 20,000 | .0014 | | |
| 5,000 | | .0003 | |
| 25,000 | .0024 | | |
| 30,000 | .0037 | | |
| 35,000 | .0053 | | |
| 5,000 | | .0012 | |
| 40,000 | .0077 | | |
| 44,000 | .0092 | | |
| 48,000 | .0110 | | |
| 50,000 | .0122 | | |
| 52,000 | .0131 | | |
| 54,000 | .0142 | | |
| 56,000 | .0152 | | |
| 58,000 | .0162 | | |
| 60,000 | .0172 | | Joint hardly disturbed. |
| 5,000 | | .0077 | |
| 62,000 | .0182 | | |
| 64,000 | .0192 | | |
| 66,000 | .0203 | | |
| 68,000 | .0217 | | |
| 70,000 | .0232 | | |
| 72,000 | .0252 | | |
| 74,000 | .0272 | | |
| 76,000 | .0294 | | |
| 78,000 | .0332 | | |
| 80,000 | .0374 | | Joint opened about ".03. |
| 82,000 | .0434 | | |
| 84,000 | .0502 | | |
| 86,000 | .0567 | | |
| 88,000 | .0670 | | |
| 90,000 | .0840 | | |
| 105,300 | | | Ultimate strength. |

Failure occurred in the same manner as with G. Appearance of fracture, silky. Metal well drawn down. Joint greasy from oil used in punching.

The slip of the plates at the calked edge after fracture measured ".20, the joint remaining open about ".05 to ".06.

*Maximum loads on joint.*

| | Pounds per sq. inch. |
|---|---|
| Tensile strain on gross section of plate | 41,460 |
| Tensile strain on net section of plate | 64,600 |
| Compressive strain on bearing surface of rivets | 63,430 |
| Shearing strain on rivets | 30,430 |

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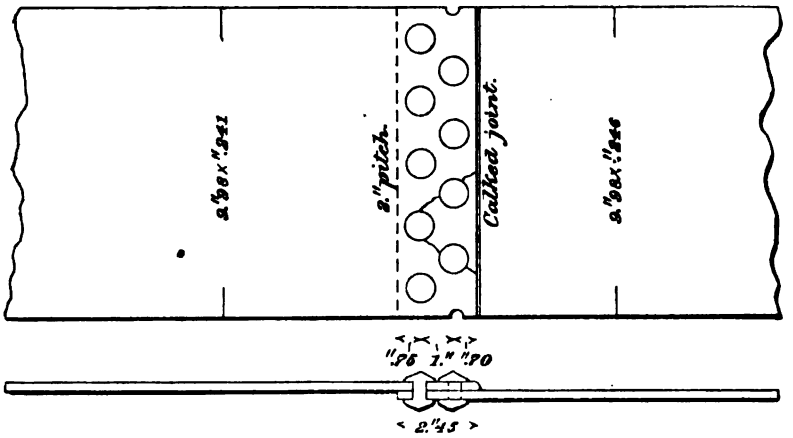
## No. 87.—¼″ Steel Plate. Joint I.




$\frac{7}{16}$″ steel rivets.
Drilled holes, ″.50 diameter.

| | Square inches. |
|---|---|
| Gross sectional area of upper plate | 2.41 |
| Net sectional area of upper plate | 1.80 |
| Bearing surface of rivets | 1.08 |
| Shearing area of rivets | 1.77 |

| Loads applied. | Elongation in 10 inches. | Permanent set. | Remarks. |
|---|---|---|---|
| *Pounds.* | *Inch.* | *Inch.* | |
| 5,000 | 0. | | |
| 10,000 | .0002 | | |
| 20,000 | .0012 | | |
| 30,000 | .0028 | | |
| 35,000 | .0038 | | |
| 40,000 | .0050 | | |
| 45,000 | .0068 | | |
| 50,000 | .0090 | | |
| 5,000 | | .0045 | |
| 55,000 | .0120 | | |
| 60,000 | .0155 | | |
| 65,000 | .0195 | | |
| 70,000 | .0240 | | |
| 75,000 | .0305 | | Joint opened perceptibly. |
| 80,000 | .0390 | | Joint opened ″.01. |
| 85,000 | .0515 | | |
| 90,000 | .0715 | | Joint opened ″.02. Rapid stretching of plate. |
| 102,500 | | | Ultimate strength. Sheared six rivets and tore out plate at three rivets. |

Average elongation of holes, about ″.15.
The minimum elongation, ″.07; maximum, ″.28.
The metal on one side of the plate proved its elastic limit before the full surface, owing to the plates not being riveted together in line.

*Maximum loads on joint.*

| | Pounds per sq. inch. |
|---|---|
| Tensile strain on gross section of plate | 42,530 |
| Tensile strain on net section of plate | 56,944 |
| Compressive strain on bearing surface of rivets | 94,910 |
| Shearing strain on rivets | 57,910 |

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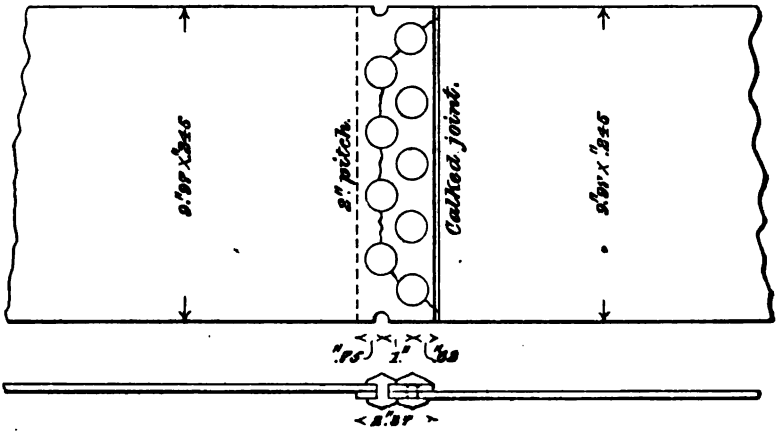
## No. 88.—¼″ Steel Plate. Joint I . .




$\frac{7}{16}$″ steel rivets.
Drilled holes, ″.50 diameter.

| | Square inches. |
|---|---|
| Gross sectional area of plate | 2.44 |
| Net sectional area of plate | 1.83 |
| Bearing surface of rivets | 1.10 |
| Shearing area of rivets | 1.77 |

| Loads applied. | Elongation in 10 inches. | Permanent set. | Remarks. |
|---|---|---|---|
| *Pounds.* | *Inch.* | *Inch.* | |
| 5,000 | 0. | | |
| 10,000 | .0010 | | |
| 20,000 | .0038 | | |
| 30,000 | .0068 | | |
| 40,000 | .0110 | | |
| 45,000 | .0135 | | |
| 50,000 | .0162 | | |
| 5,000 | | .0070 | |
| 55,000 | .0198 | | |
| 60,000 | .0232 | | |
| 65,000 | .0280 | | |
| 70,000 | .0320 | | |
| 75,000 | .0370 | | |
| 80,000 | .0455 | | Joint opened perceptibly. |
| 85,000 | .0570 | | Joint opened .″01. |
| 90,000 | .0750 | | |
| 95,000 | .1450 | | Joint opened .″02. |
| 108,200 | | | Ultimate strength. Tore upper plate, as shown by lines on sketch. |

Fine silky fractures; metal well drawn down.

*Maximum loads on joint.*

| | Pounds per sq. inch. |
|---|---|
| Tensile strain on gross section of plate | 44,344 |
| Tensile strain on net section of plate | 59,130 |
| Compressive strain on bearing surface of rivets | 98,360 |
| Shearing strain on rivets | 61,130 |

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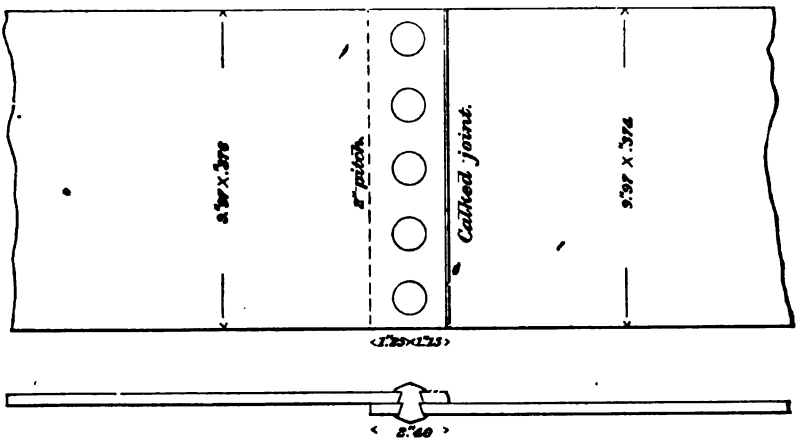
## SINGLE-RIVETED LAP JOINTS, ⅜″ STEEL PLATE.

### No. 51.—⅜″ Steel Plate. Joint A.




11/16″ iron rivets, "Burden's best."
Punched holes: Punch, ".753 diameter; die, ".774 diameter.

| | Square inches. |
|---|---|
| Gross sectional area of lower plate | 3.73 |
| Net sectional area of lower plate | 2.30 |
| Bearing surface of rivets | 1.427 |
| Shearing area of rivets (".76 diameter) | 2.27 |

| Loads applied. | Elongation in 10 inches. | Permanent set. | Remarks. |
|---|---|---|---|
| *Pounds.* | *Inch.* | *Inch.* | |
| 5,000 | 0. | | |
| 10,000 | .0008 | | |
| 20,000 | .0022 | | |
| 30,000 | .0060 | | |
| 35,000 | .0082 | | |
| 5,000 | | .0038 | |
| 40,000 | .0115 | | |
| 45,000 | .0140 | | |
| 50,000 | .0182 | | |
| 55,000 | .0248 | | |
| 60,000 | .0328 | | Joint opened less than ".01. |
| 65,000 | .0495 | | Joint opened ".02. |
| 70,000 | .0699 | | Joint opened ".04. |
| 75,000 | .0980 | | |
| 90,200 | | | Ultimate strength. Sheared rivets. |

Rivet holes elongated from ".03 to ".05.

*Maximum loads on joint.*

| | Pounds per sq. inch. |
|---|---|
| Tensile strain on gross section of plate | 24,180 |
| Tensile strain on net section of plate | 39,220 |
| Compressive strain on bearing surface of rivets | 63,210 |
| Shearing strain on rivets | 39,740 |

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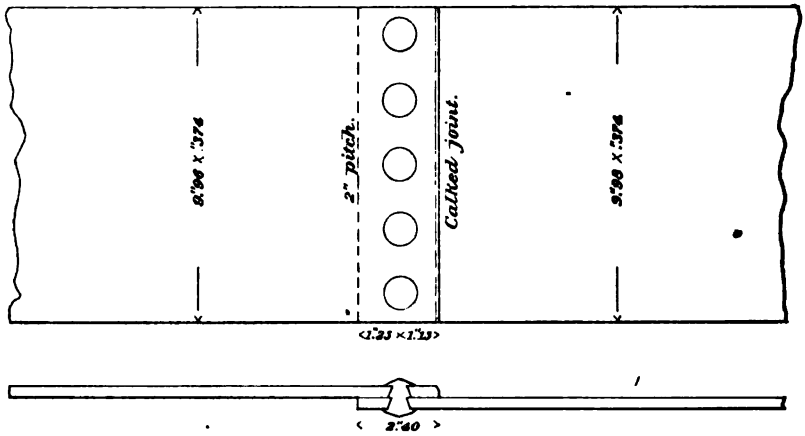
## No. 52.—$\frac{3}{8}$" Steel Plate. Joint A . .




$\frac{11}{16}$" iron rivets, "Burden's best."
Punched holes.

| | Square inches. |
|---|---|
| Gross sectional area of upper plate | 3.73 |
| Net sectional area of upper plate | 2.30 |
| Bearing surface of rivets | 1.427 |
| Shearing area of rivets (".76 diameter) | 2.27 |

| Loads applied. | Elongation in 10 inches. | Permanent set. | Remarks. |
|---|---|---|---|
| *Pounds.* | *Inch.* | *Inch.* | |
| 5,000 | .0 | | |
| 10,000 | .0008 | | |
| 20,000 | .0020 | | |
| 30,000 | .0060 | | |
| 35,000 | .0085 | | Joint started perceptibly. |
| 5,000 | | .0039 | |
| 38,000 | .0108 | | |
| 40,000 | .0118 | | |
| 42,000 | .0130 | | |
| 44,000 | .0145 | | |
| 46,000 | .0158 | | |
| 48,000 | .0172 | | |
| 50,000 | .0189 | | Joint opened about ".01. |
| 52,000 | .0206 | | |
| 54,000 | .0230 | | |
| 56,000 | .0265 | | |
| 58,000 | .0318 | | |
| 60,000 | .0370 | | Joint opened ".02. |
| 62,000 | .0420 | | |
| 64,000 | .0485 | | Joint opened ".04. |
| 66,000 | .0560 | | |
| 68,000 | .0635 | | Joint opened ".05. |
| 70,000 | .0728 | | |
| 5,000 | | .0553 | |
| 86,700 | | | Ultimate strength. Sheared rivets. |

Rivet holes elongated from ".03 to ".05.

*Maximum loads on joint.*

| | Pounds per sq. inch. |
|---|---|
| Tensile strain on gross section of plate | 23,240 |
| Tensile strain on net section of plate | 37,700 |
| Compressive strain on bearing surface of rivets | 60,760 |
| Shearing strain on rivets | 38,190 |

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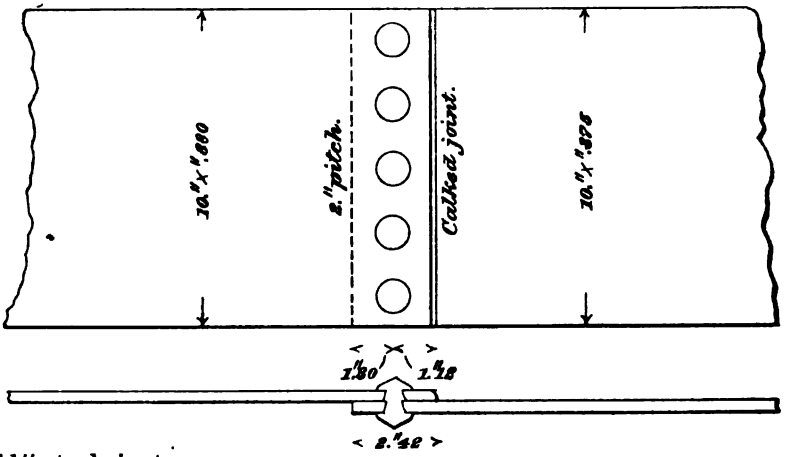
## No. 53.—⅜″ STEEL PLATE. JOINT A A.




$\frac{11}{16}$″ steel rivets.

Punched holes: Punch, ″.753 diameter; die, ″.774 diameter.

| | Square inches. |
|---|---|
| Gross sectional area of lower plate | 3.75 |
| Net sectional area of lower plate | 2.32 |
| Bearing surface of rivets | 1.43 |
| Shearing area of rivets (″.76 diameter) | 2.27 |

| Loads applied. | Elongation in 10 inches. | Permanent set. | Remarks. |
|---|---|---|---|
| *Pounds.* | *Inch.* | *Inch.* | |
| 5,000 | 0. | | |
| 10,000 | .0008 | | |
| 20,000 | .0025 | | |
| 30,000 | .0060 | | |
| 35,000 | .0080 | | |
| 5,000 | | .0030 | |
| 38,000 | .0095 | | |
| 40,000 | .0110 | | |
| 44,000 | .0120 | | |
| 46,000 | .0130 | | |
| 48,000 | .0142 | | |
| 50,000 | .0159 | | |
| 52,000 | .0172 | | |
| 54,000 | .0190 | | Joint opened slightly. |
| 56,000 | .0203 | | |
| 58,000 | .0230 | | |
| 60,000 | .0260 | | |
| 62,000 | .0300 | | Joint opened ″.01. |
| 64,000 | .0340 | | |
| 66,000 | .0382 | | Joint open ″.02. |
| 68,000 | .0420 | | |
| 70,000 | .0461 | | Joint open ″.03. |
| 72,000 | .0510 | | |
| 74,000 | .0558 | | Joint open ″.04. |
| 76,000 | .0605 | | |
| 78,000 | .0661 | | Joint open ″.05. |
| 80,000 | .0725 | | |
| 82,000 | .0789 | | |
| 84,000 | .0845 | | |
| 86,000 | .0908 | | |
| 88,000 | .0980 | | |
| 90,000 | .1060 | | |
| 128,100 | | | Ultimate strength. Sheared rivets. |

Average elongation of holes, ″.12.

Incipient fractures about rivet holes, indicating a close approach to the ultimate strength of the plate.

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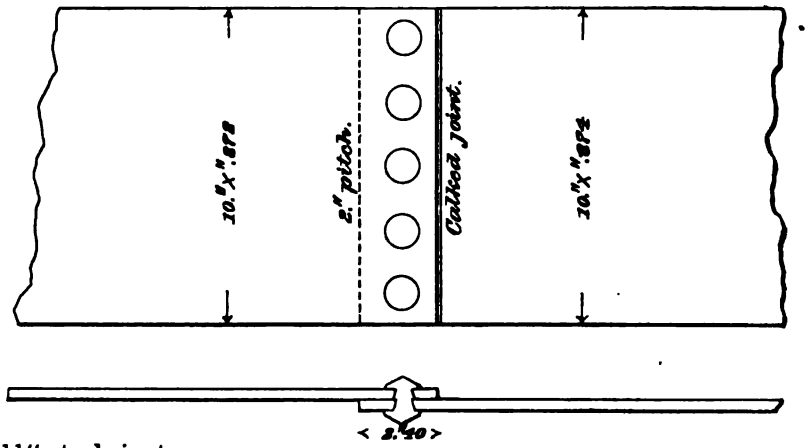
*Maximum loads on joint.*

| | Pounds per sq. inch. |
|---|---|
| Tensile strain on gross section of lower plate | 34,160 |
| Tensile strain on net section of lower plate | 55,215 |
| Compressive strain on bearing surface of rivets | 89,580 |
| Shearing strain on rivets | 56,430 |

## No. 54.—⅜″ Steel Plate. Joint A A . .




$\frac{11}{16}$″ steel rivets.

Punched holes: Punch, ″.753 diameter; die, ″.774 diameter.

| | Square inches. |
|---|---|
| Gross sectional area of lower plate | 3.75 |
| Net sectional area of lower plate | 2.32 |
| Bearing surface of rivets | 1.42 |
| Shearing area of rivets (″.76 diameter) | 2.27 |

| Loads applied. | Elongation in 10 inches. | Permanent set. | Remarks. |
|---|---|---|---|
| *Pounds.* | *Inch.* | *Inch.* | |
| 5,000 | 0. | | |
| 10,000 | .0008 | | |
| 20,000 | .0020 | | |
| 30,000 | .0048 | | |
| 40,000 | .0090 | | |
| 50,000 | .0149 | | |
| 60,000 | .0251 | | Joint open about ″.01. |
| 70,000 | .0450 | | |
| 80,000 | .0688 | | |
| 90,000 | .1038 | | |
| 125,900 | | | Ultimate strength. Sheared rivets. |

Incipient fracture about rivet holes same as were developed in specimen A A .

*Maximum loads on joint.*

| | Pounds per sq. inch. |
|---|---|
| Tensile strain on gross section of upper plate | 33,840 |
| Tensile strain on net section of upper plate | 54,740 |
| Compressive strain on bearing surface of rivets | 88,660 |
| Shearing strain on rivets | 55,460 |

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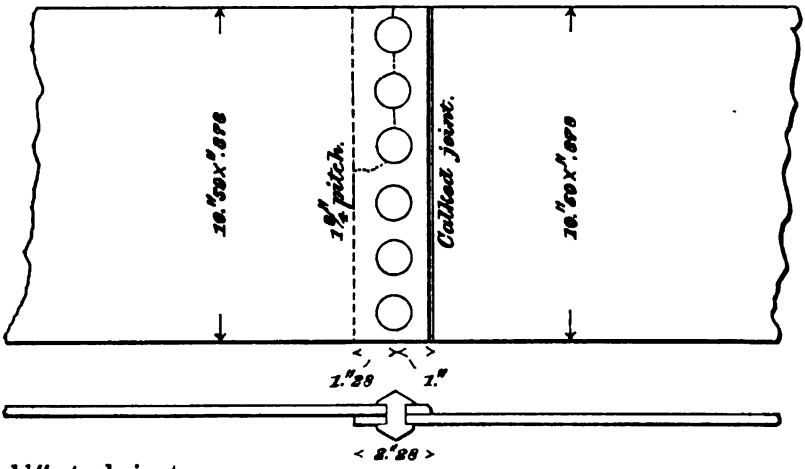
## No. 55.—⅜″ Steel Plate. Joint E.




⅞″ steel rivets.
Drilled holes, ″.77 diameter.

| | Square inches. |
|---|---|
| Gross sectional area of plate | 3.97 |
| Net sectional area of plate | 2.22 |
| Bearing surface of rivets | 1.746 |
| Shearing area of rivets (″.77 diameter) | 2.79 |

| Loads applied. | Elongation in 10 inches. | Permanent set. | Remarks. |
|---|---|---|---|
| *Pounds.* | *Inch.* | *Inch.* | |
| 5,000 | 0. | | |
| 10,000 | .0006 | | |
| 20,000 | .0016 | | |
| 30,000 | .0032 | | |
| 35,000 | .0048 | | |
| 5,000 | | .0011 | |
| 40,000 | .0070 | | |
| 45,000 | .0096 | | Joint opened perceptibly. |
| 50,000 | .0126 | | |
| 55,000 | .0156 | | |
| 60,000 | .0190 | | Joint open ″.01. |
| 65,000 | .0245 | | |
| 68,000 | .0282 | | Joint open ″.02. |
| 70,000 | .0330 | | |
| 72,000 | .0362 | | Joint open ″.03. |
| 75,000 | .0420 | | |
| 78,000 | .0480 | | Joint open ″.04. |
| 80,000 | .0522 | | |
| 85,000 | .0640 | | |
| 90,000 | .0770 | | |
| 100,090 | .1100 | | |
| 124,400 | | | Scale starts off entire plate. |
| 141,300 | | | Ultimate strength. |

Sheared three rivets and tore apart the lower plate across three rivet holes, the metal showing a silky fracture, and drawing down well.

*Maximum loads on joint.*

| | Pounds per sq. inch. |
|---|---|
| Tensile strain on gross section of plate | 35,590 |
| Tensile strain on net section of plate | 63,650 |
| Compressive strain on bearing surface of rivets | 80,930 |
| Shearing strain on rivets | 50,650 |

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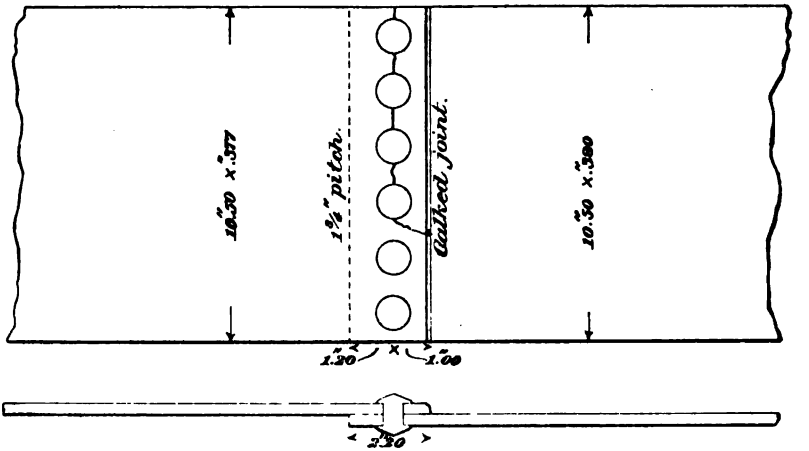
## No. 56.—⅜″ Steel Plate. Joint E . .




$\frac{11}{16}$″ steel rivets.
Drilled holes, ″.77 diameter.

| | Square inches. |
|---|---|
| Gross sectional area of upper plate | 3.96 |
| Net sectional area of upper plate | 2.22 |
| Bearing surface of rivets | 1.74 |
| Shearing area of rivets (″.77 diameter) | 2.79 |

| Loads applied. | Elongation in 10 inches. | Permanent set. | Remarks. |
|---|---|---|---|
| *Pounds.* | *Inch.* | *Inch.* | |
| 5,000 | 0. | | Plates not straight. |
| 10,000 | 0. | | |
| 20,100 | .0010 | | |
| 30,000 | .0018 | | |
| 35,000 | .0021 | | |
| 5,000 | | .0005 | |
| 40,000 | .0039 | | |
| 45,000 | .0056 | | |
| 50,000 | .0085 | | Joint opened perceptibly at 53,000 pounds tension. |
| 55,000 | .0125 | | |
| 60,000 | .0168 | | |
| 65,000 | .0225 | | Joint open ″.01. |
| 68,000 | .0278 | | |
| 70,000 | .0310 | | Joint open ″.02. |
| 72,000 | .0348 | | |
| 75,000 | .0410 | | Joint open ″.03. |
| 78,000 | .0480 | | Joint open ″.04. |
| 80,000 | .0530 | | Joint open ″.05. |
| 85,000 | .0680 | | |
| 90,000 | .0860 | | |
| 95,000 | .1110 | | |
| 100,000 | .1350 | | |
| 122,000 | | | Scale starts off plates. |
| 142,000 | | | Ultimate strength. |

Sheared two rivets and tore plate across four rivet holes in upper plate.
Silky fractures, the metal well drawn down.

*Maximum loads on joint.*

| | Pounds per sq. inch. |
|---|---|
| Tensile strain on gross section of upper plate | 35,860 |
| Tensile strain on net section of upper plate | 63,976 |
| Compressive strain on bearing surface of rivets | 81,600 |
| Shearing strain on rivets | 50,900 |

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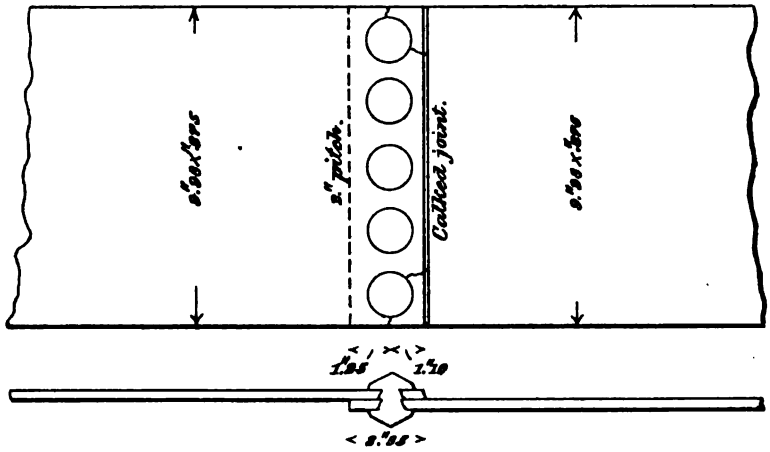
## No. 238.—⅜″ Steel Plate. Joint C C.




⅜″ steel rivets.
Punched holes: Punch, $\frac{13}{16}$″ diameter; die, ⅞″ diameter.

| | Square inches. |
|---|---|
| Gross sectional area of upper plate | 3.74 |
| Net sectional area of upper plate | 2.16 |
| Bearing surface of rivets | 1.58 |
| Shearing area of rivets (".82 diameter) | 2.64 |

| Loads applied. | Elongation in 10 inches. | Permanent set. | Remarks. |
|---|---|---|---|
| *Pounds.* | *Inch.* | *Inch.* | |
| 5,000 | 0. | | |
| 10,000 | .0010 | | |
| 20,000 | .0030 | | |
| 30,000 | .0055 | | |
| 35,000 | .0070 | | |
| 5,000 | | .0012 | |
| 40,000 | .0090 | | |
| 45,000 | .0112 | | |
| 50,000 | .0135 | | |
| 55,000 | .0165 | | |
| 60,000 | .0200 | | |
| 65,000 | .0242 | | Joint opened perceptibly. |
| 5,000 | | .0130 | |
| 70,000 | .0308 | | Joint open ".01. |
| 75,000 | .0380 | | |
| 80,000 | .0540 | | Joint open ".02. |
| 85,000 | .0700 | | Joint open ".03. |
| 90,000 | .0830 | | |
| 95,000 | .0990 | | Joint open ".04. |
| 100,000 | .1150 | | Joint open ".05. |
| 105,000 | .1360 | | |
| 110,000 | .1630 | | |
| 141,400 | | | Ultimate strength. Sheared three rivets. Tore upper plate at end rivets. |

*Maximum loads on joint.*

| | Pounds per sq. inch. |
|---|---|
| Tensile strain on gross section of plate | 37,810 |
| Tensile strain on net section of plate | 65,460 |
| Compressive strain on bearing section of rivets | 89,490 |
| Shearing strain on rivets | 53,560 |

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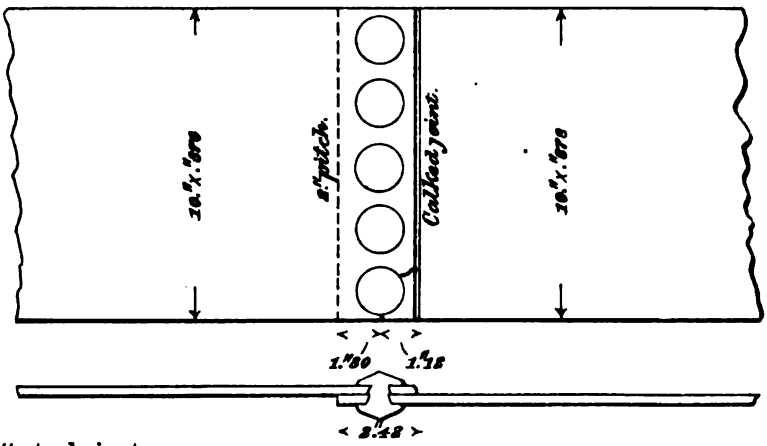
## No. 239.—$\frac{3}{8}$″ Steel Plate. Joint C C . .




$\frac{3}{4}$″ steel rivets.

Punched holes: Punch, $\frac{13}{16}$″ diameter; die, $\frac{7}{8}$″ diameter.

| | Square inches |
|---|---|
| Gross sectional area of upper plate | 3.76 |
| Net sectional area of upper plate | 2.17 |
| Bearing surface of rivets | 1.59 |
| Shearing area of rivets (″.82 diameter) | 2.64 |

| Loads applied. | Elongation in 10 inches. | Permanent set. | Remarks. |
|---|---|---|---|
| *Pounds.* | *Inch.* | *Inch.* | |
| 5,000 | 0. | | |
| 10,000 | .0006 | | |
| 20,000 | .0019 | | |
| 30,000 | .0045 | | |
| 35,000 | .0060 | | |
| 5,000 | | .0018 | |
| 40,000 | .0079 | | |
| 45,000 | .0095 | | |
| 50,000 | .0112 | | |
| 5,000 | | .0032 | |
| 55,000 | .0140 | | |
| 60,000 | .0170 | | |
| 65,000 | .0212 | | Joint opened perceptibly. |
| 5,000 | | .0106 | |
| 70,000 | .0295 | | Joint open ″.01. |
| 75,000 | .0380 | | |
| 80,000 | .0520 | | Joint open ″.02. |
| 85,000 | .0660 | | |
| 90,000 | .0790 | | Joint open ″.04. |
| 100,000 | .1125 | | Micrometer removed. |
| 110,000 | .1600 | | |
| 120,000 | .2800 | | |
| 130,000 | .4700 | | |
| 140,000 | .6800 | | |
| 141,500 | .7800 | | Ultimate strength. Sheared four rivets. Tore out plate at end rivet, upper plate. |

At time of maximum load the joint had slipped at the calked end ″.40.

Elongation of holes in upper plate, punch side, ″.15; die side, ″29. Elongation of holes in lower plate, punch side, ″.13; die side, ″.07.

Fractures were started about two holes in the upper plate where the rivets had sheared, showing the metal was near the point of tearing out.

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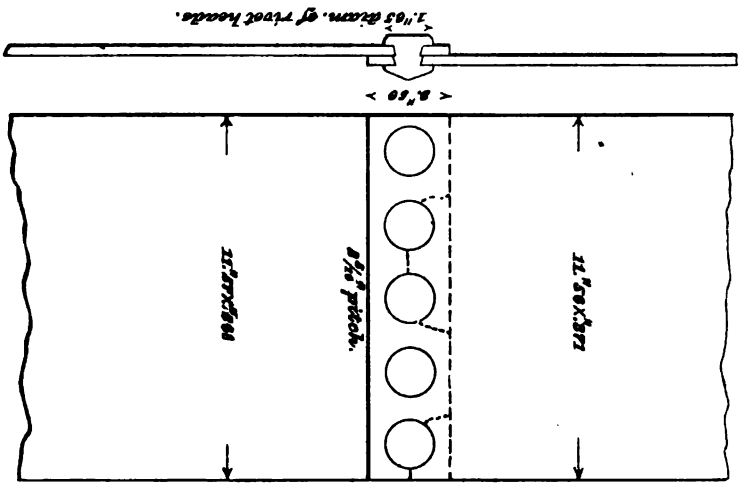
*Maximum loads on joint.*

| | Pounds per sq. inch. |
|---|---|
| Tensile strain on gross section of plate | 37,630 |
| Tensile strain on net section of plate | 65,210 |
| Compressive strain on bearing surface of rivets | 88,990 |
| Shearing strain on rivets | 53,600 |

## No. 718.—$\frac{3}{8}$″ Steel Plate. Set K.



1″ iron rivets, hand-driven.
Punched holes: Punch, $1\frac{1}{16}$″ diameter; die, $1\frac{5}{32}$″ diameter.

| | Square inches. |
|---|---|
| Gross sectional area of under plate | 4.26 |
| Net sectional area of under plate | 2.21 |
| Bearing surface of rivets | 2.04 |
| Shearing area of rivets | 4.43 |

| Loads applied. | Elongation in 10 inches. | Permanent set. | Remarks. |
|---|---|---|---|
| *Pounds.* | *Inch.* | *Inch.* | |
| 5,000 | 0. | | |
| 10,000 | .0008 | | |
| 20,000 | .0028 | | |
| 30,000 | .0050 | | |
| 35,000 | .0068 | | |
| 5,000 | | .0020 | |
| 40,000 | .0088 | | |
| 45,000 | .0118 | | |
| 50,000 | .0148 | | |
| 55,000 | .0180 | | |
| 60,000 | .0215 | | |
| 65,000 | .0252 | | |
| 70,000 | .0298 | | |
| 75,000 | .0340 | | |
| 80,000 | .0388 | | |
| 90,000 | .07 | | |
| 100,000 | .11 | | |
| 110,000 | .14 | | |
| 120,000 | .19 | | |
| 130,000 | .24 | | |
| 140,000 | .30 | | |
| 150,000 | .49 | | |
| 162,200 | | | Ultimate strength. |

Sheared two rivets and tore out plate at three rivets under plate.
Elongation of two rivet holes, ″.26 each.
Fracture of plate silky.



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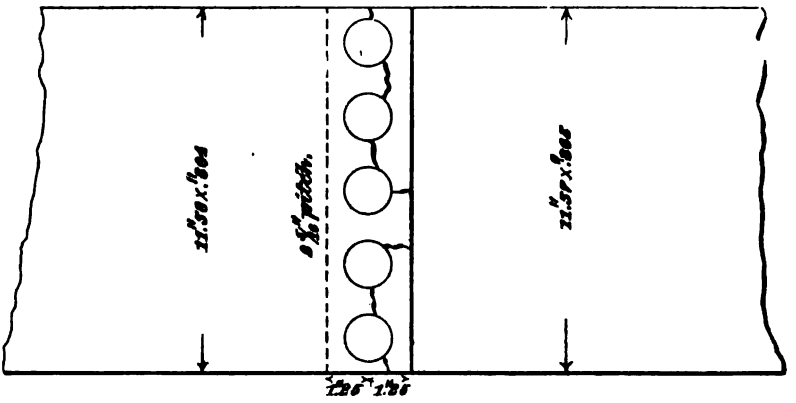
*Maximum loads on joint.*

| | Pounds per sq. inch. |
|---|---|
| Tensile strain on gross section of under plate | 38,075 |
| Tensile strain on net section of under plate | 73,394 |
| Compressive strain on bearing surface of rivets | 79,510 |
| Shearing strain on rivets | 36,614 |

## No. 719.—$\frac{3}{8}$″ Steel Plate. Set K . .

### Duplicate of K .



1″ iron rivets, hand-driven.
Punched holes: Punch, $1\frac{1}{16}$″ diameter; die, $1\frac{5}{32}$″ diameter.

| | Square inches. |
|---|---|
| Gross sectional area of upper plate | 4.22 |
| Net sectional area of upper plate | 2.19 |
| Bearing surface of rivets | 2.02 |
| Shearing area of rivets | 4.43 |

| Loads applied. | Elongation in 10 inches. | Permanent set. | Remarks. |
|---|---|---|---|
| *Pounds.* | *Inch.* | *Inch.* | |
| 5,000 | 0. | ..... | |
| 10,000 | .0010 | ..... | |
| 20,000 | .0030 | ..... | |
| 30,000 | .0051 | ..... | |
| 35,000 | .0065 | ..... | |
| 5,000 | ..... | .0008 | |
| 40,000 | .0080 | ..... | |
| 45,000 | .0100 | ..... | |
| 55,000 | .0150 | ..... | |
| 60,000 | .0161 | ..... | |
| 65,000 | .0200 | ..... | |
| 70,000 | .0240 | ..... | |
| 75,000 | .0290 | ..... | |
| 80,000 | .0340 | ..... | |
| 85,000 | .0388 | ..... | |
| 90,000 | .048 | ..... | |
| 95,000 | .056 | ..... | |
| 100,000 | .070 | ..... | |
| 110,000 | .11 | ..... | |
| 120,000 | .13 | ..... | |
| 130,000 | .18 | ..... | |
| 140,000 | .24 | ..... | |
| 150,000 | .47 | ..... | |
| 160,000 | .67 | ..... | |
| 162,000 | ..... | ..... | Ultimate strength. |

Tore out upper plate.

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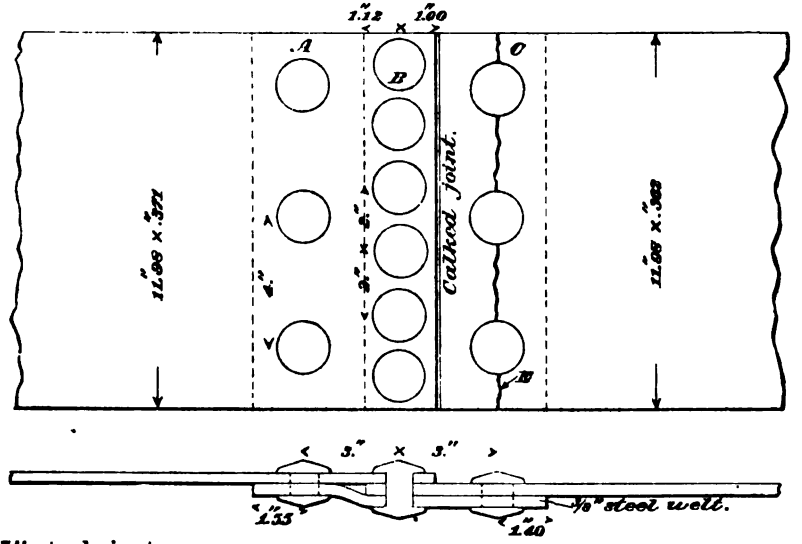
*Maximum loads on joint.*

| | Pounds per sq. inch. |
|---|---|
| Tensile strain on gross section of upper plate | 38,390 |
| Tensile strain on net section of upper plate | 73,970 |
| Compressive strain on bearing surface of rivets | 80,200 |
| Shearing strain on rivets | 36,590 |

SINGLE-RIVETED LAP JOINTS, WITH REINFORCE WELT, $\frac{1}{4}$" STEEL PLATE.

No. 246.—$\frac{3}{8}$" STEEL PLATE. JOINT J.




$\frac{7}{8}$" steel rivets.
Drilled holes, ".94 diameter.

| | Square inches. |
|---|---|
| Gross sectional area of under plate | 4.34 |
| Net sectional area of under plate through line of holes *B* | 2.30 |
| Net sectional area of under plate through line of holes *C* | 3,32 |
| Bearing surface of rivets (9) on under plate | 3.06 |
| Shearing area of 9 rivets (".94 diameter), single shear | 6.25 |

| Loads applied. | Elongation in 10 inches. | Permanent set. | Remarks. |
|---|---|---|---|
| *Pounds.* | *Inch.* | *Inch.* | |
| 5,000 | 0. | | |
| 10,000 | .0005 | | |
| 20,000 | .0018 | | |
| 30,000 | .0030 | | |
| 35,000 | .0038 | | |
| 5,000 | | .0010 | |
| 40,000 | .0045 | | |
| 50,000 | .0055 | | |
| 60,000 | .0092 | | |
| 5,000 | | .0038 | |
| 65,000 | .0112 | | |
| 70,000 | .0130 | | |
| 75,000 | .0148 | | |
| 80,000 | .0160 | | |
| 85,000 | .0180 | | |
| 90,000 | .0200 | | |
| 95,000 | .0218 | | Joint opened perceptibly. |
| 100,000 | .0240 | | |
| 5,000 | | .0131 | |
| 105,000 | .0270 | | |
| 110,000 | .0295 | | |

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| Loads applied. | Elongation in 10 inches. | Permanent set | Remarks. |
|---|---|---|---|
| *Pounds.* | *Inch.* | *Inch.* | |
| 115,000 | .0325 | ..... | Joint open ".01. |
| 120,000 | .0365 | ..... | |
| 125,000 | .0418 | ..... | |
| 130,000 | .0480 | ..... | |
| 135,000 | .0580 | ..... | |
| 140,000 | .0820 | ..... | Micrometer removed. |
| 145,000 | .13 | ..... | |
| 150,000 | .16 | ..... | |
| 155,000 | .21 | ..... | |
| 206,000 | ..... | ..... | Ultimate strength. Fractured under plate at outside row of rivets. |

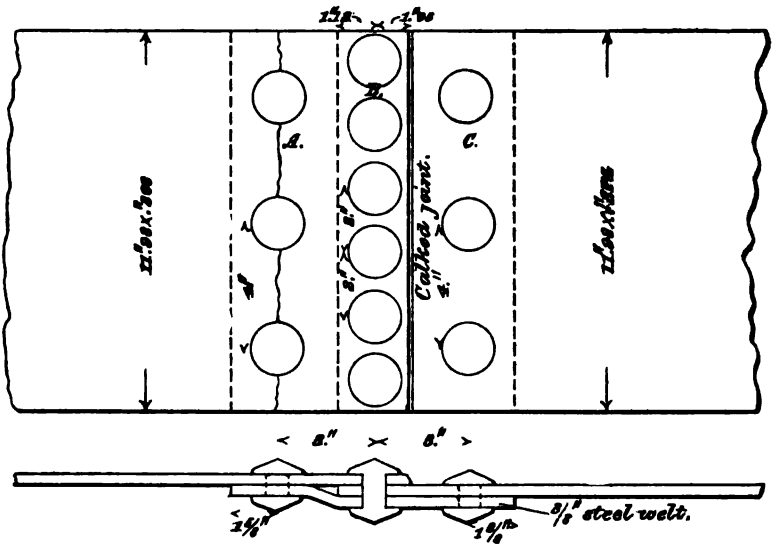
Fracture, silky seam in steel through one end section at *E*. After fracture, holes in welt elongated about ".02 each; upper plate, outside row of 3 holes, elongated ".20; upper plate, inside row of 6 holes, elongated ".06.

Before fracture the plates drew down from 11".98 to about 11".68 in width; the line of the joint bent concave and wavy.

*Maximum loads on joint.*

| | Pounds per sq. inch. |
|---|---|
| Tensile strain on gross section of lower plate | 47,465 |
| Tensile strain on net section of under plate through line of holes *B* | 89,565 |
| Tensile strain on net section of under plate through line of holes *C* | 62,050 |
| Shearing strain on 9 rivets, single shear | 32,960 |
| Compressive strain on bearing surface of rivets (9) in under plate | 67,320 |

## No. 247.—⅜" Steel Plate. Joint J..




⅞" steel rivets.
Drilled holes, ".94 diameter.
⅜" steel welt.

| | Square inches. |
|---|---|
| Gross sectional area of upper plate | 4.41 |
| Net sectional area of upper plate through line of holes *A* | 3.37 |
| Net sectional area of upper plate through line of holes *B* | 2.33 |
| Bearing surface of 9 rivets, upper plate | 3.11 |
| Shearing area of 9 rivets (".94 diameter), single shear | 6.25 |

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| Loads applied. | Elongation in 10 inches. | Permanent set. | Remarks. |
|---|---|---|---|
| *Pounds.* | *Inch.* | *Inch.* | |
| 5,000 | 0. | | |
| 10,000 | .0005 | | |
| 20,000 | .0012 | | |
| 30,000 | .0022 | | |
| 35,000 | .0029 | | |
| 5,000 | | .0010 | |
| 40,000 | .0088 | | |
| 50,000 | .0058 | | |
| 60,000 | .0080 | | |
| 5,000 | | .0038 | |
| 65,000 | .0098 | | |
| 70,000 | .0110 | | |
| 75,000 | .0128 | | |
| 80,000 | .0142 | | |
| 85,000 | .0158 | | |
| 90,000 | .0170 | | Joint opened perceptibly. |
| 95,000 | .0188 | | |
| 100,000 | .0200 | | |
| 5,000 | | .0108 | |
| 105,000 | .0222 | | |
| 110,000 | .0240 | | |
| 115,000 | .0262 | | |
| 120,000 | .0295 | | |
| 125,000 | .0330 | | |
| 130,000 | .0382 | | |
| 135,000 | .0460 | | |
| 140,000 | .0640 | | Micrometer removed. |
| 145,000 | .12 | | |
| 150,000 | .15 | | |
| 155,000 | .18 | | |
| 160,000 | .22 | | |
| 165,000 | .26 | | |
| 170,000 | .30 | | |
| 175,000 | .34 | | |
| 180,000 | .37 | | |
| 185,000 | .43 | | |
| 190,000 | .48 | | |
| 195,000 | .52 | | |
| 200,000 | .58 | | |
| 205,000 | .68 | | |
| 210,000 | .79 | | |
| 211,900 | | | Ultimate strength. Fractured upper plate through outside row of rivets. |

Fracture began at end rivet hole. This outside section has seam through the steel, same in appearce as developed in the test of J .
Fractures otherwise silky.

*Maximum loads on joint.*

| | Pounds per sq. inch. |
|---|---|
| Tensile strain on gross section of upper plate | 48,050 |
| Tensile strain on net section of upper plate across lines of holes *A* | 62,880 |
| Tensile strain on net section of upper plate across lines of holes *B* | 90,940 |
| Compressive strain on bearing surface of 9 rivets, upper plate | 68,135 |
| Shearing strain on 9 rivets, single shear | 33,90 |

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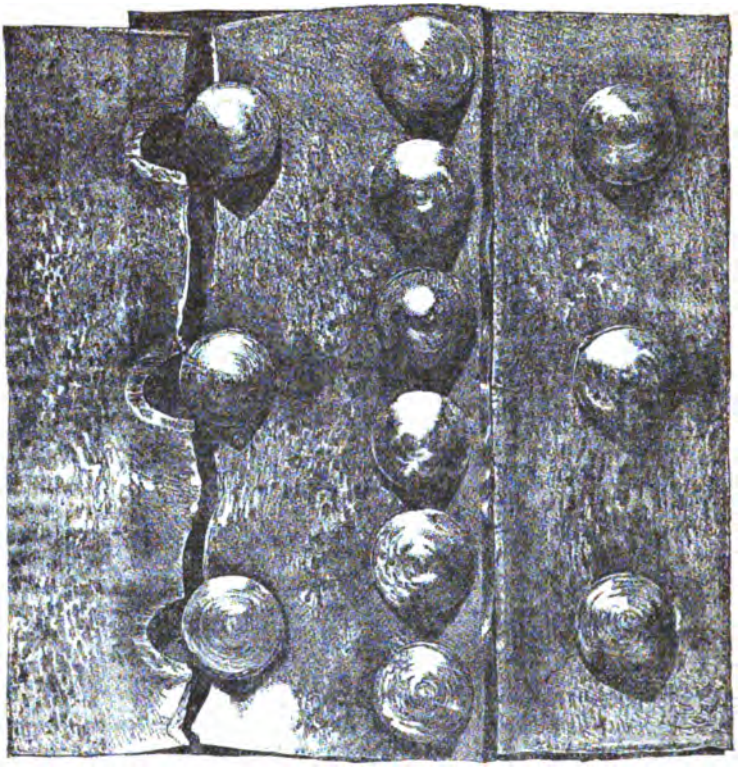
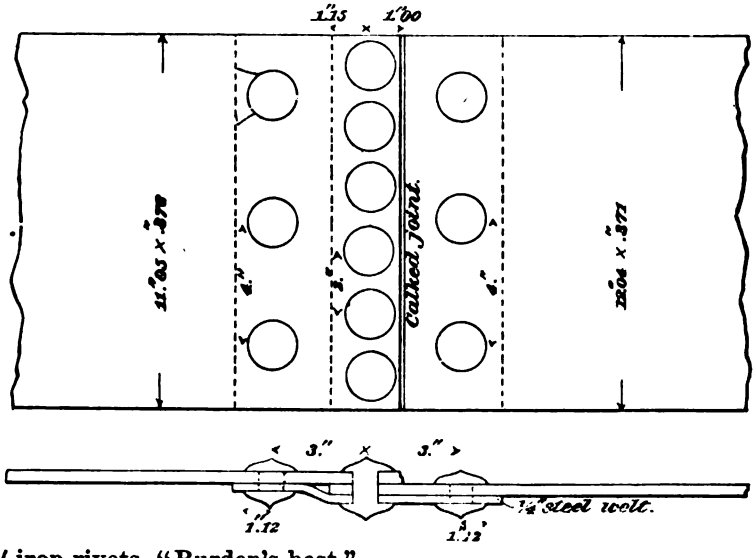


Photograph of joint No. 247. Appearance after the fracture.

## No. 298.—$\frac{3}{8}$″ Steel Plates. Joint J J.




$\frac{7}{8}$″ iron rivets, "Burden's best."
Drilled holes, ".93 diameter.

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| | Square inches. |
|---|---|
| Gross sectional area of under plate | 4.47 |
| Net sectional area of under plate across row of three rivet holes | 3.43 |
| Bearing surface of rivets | 3.11 |
| Shearing area of rivets (9 rivets, single shear) | 6.11 |

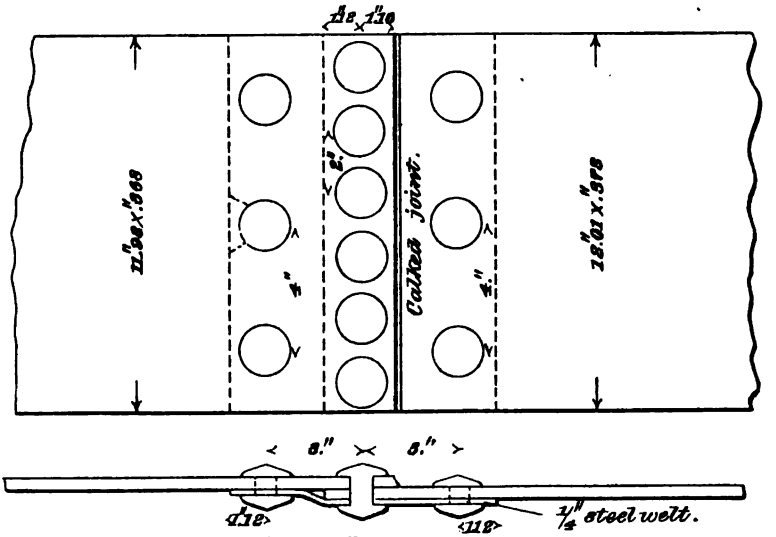
| Loads applied. | Elongation in 10 inches. | Permanent set. | Remarks. |
|---|---|---|---|
| *Pounds.* | *Inch.* | *Inch.* | |
| 5,000 | .0 | | |
| 10,000 | .0005 | | |
| 20,000 | .0015 | | |
| 30,000 | .0028 | | |
| 40,000 | .0046 | | |
| 50,000 | .0075 | | |
| 5,000 | | .0018 | |
| 60,000 | .0108 | | |
| 70,000 | .0150 | | |
| 80,000 | .0198 | | |
| 90,000 | .0248 | | |
| 100,000 | .0320 | | |
| 110,000 | .0400 | | |
| 120,000 | .0560 | | |
| 130,000 | .09 | | |
| 140,000 | .11 | | |
| 150,000 | .17 | | |
| 209,300 | | | Ultimate strength. Sheared eight rivets and tore out one hole in ½" welt. |

| | Inch. |
|---|---|
| Average elongation of rivet holes in upper plate, outside row (3 holes) | .32 each. |
| Upper plate, inside row (6 holes) | .24 each. |
| Lower plate, inside row (6 holes) | .26 each. |
| ½" welt, inside row (6 holes) | about .02 each. |
| ½" welt, outside row (3 holes) | .31 each. |

*Maximum loads on joint.*

| | Pounds per sq. inch. |
|---|---|
| Tensile strain on gross section of under plate | 46,820 |
| Tensile strain on net section of under plate across line of three rivet holes | 61,020 |
| Compressive strain on bearing surface of rivets | 67,300 |
| Shearing strain on rivets (single shear) | 34,250 |

## No. 299.—⅜" Steel Plate. Joint J J . .




⅞" iron rivets, "Burden's best."
Drilled holes, ".93 diameter.

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| | Square inches. |
|---|---|
| Gross sectional area of under plate | 4.48 |
| Net sectional area of under plate across row of three rivet holes | 3.44 |
| Bearing surface of rivets | 3.12 |
| Shearing area of rivets (single shear) | 6.11 |

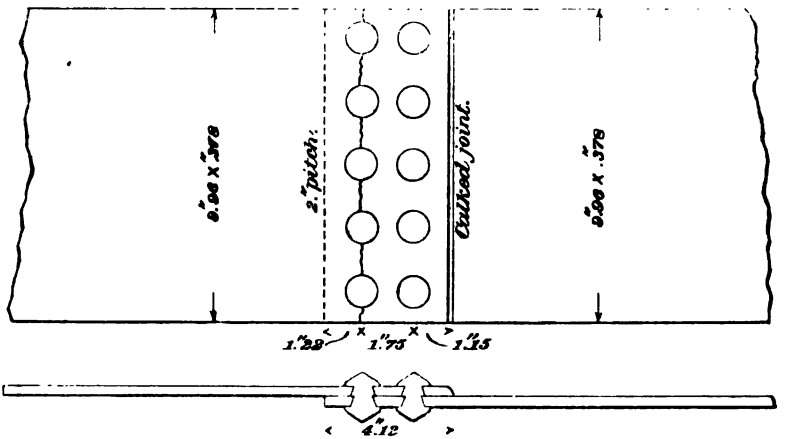
| Loads applied. | Elongation in 10 inches. | Permanent set. | Remarks. |
|---|---|---|---|
| *Pounds.* | *Inch.* | *Inch.* | |
| 5,000 | .0 | | |
| 10,000 | .0005 | | |
| 20,000 | .0010 | | |
| 30,000 | .0022 | | |
| 40,000 | .0042 | | |
| 50,000 | .0072 | | |
| 5,000 | | .0022 | |
| 60,000 | .0110 | | |
| 70,000 | .0148 | | |
| 80,000 | .0190 | | |
| 90,000 | .0230 | | |
| 100,000 | .029 | | |
| 110,000 | .06 | | |
| 120,000 | .07 | | |
| 130,000 | .08 | | |
| 140,000 | .11 | | |
| 150,000 | .19 | | |
| 212,300 | | | Ultimate strength. Sheared eight rivets; tore out ¼" welt at middle rivet, outside row. |

*Maximum loads on joint.*

| | Pounds per sq. inch. |
|---|---|
| Tensile strain on gross section of under plate | 47,390 |
| Tensile strain on net section of under plate across row of three rivet holes | 61,710 |
| Compressive strain on bearing surface of rivets | 68,040 |
| Shearing strain on rivets (single shear) | 34,750 |

## DOUBLE-RIVETED LAP-JOINTS, ⅜" STEEL PLATE.

### No. 57.—⅜" STEEL PLATE. JOINT F.




$\frac{11}{16}$" iron rivets, "Burden's best."
Punched holes: Punch, ".753 diameter; die, ".774 diameter.

| | Square inches. |
|---|---|
| Gross sectional area of plate | 3.76 |
| Net sectional area of plate | 2.32 |
| Bearing surface of rivets | 2.89 |
| Shearing area of rivets (".76 diameter) | 4.54 |

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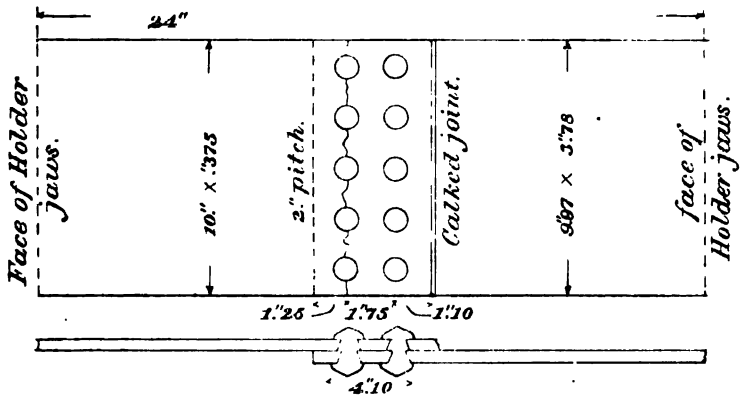
| Loads applied. | Elongation in 10 inches. | Permanent set. | Remarks. |
|---|---|---|---|
| *Pounds.* | *Inch.* | *Inch.* | |
| 5,000 | 0. | | |
| 10,000 | .0010 | | |
| 20,000 | .0030 | | |
| 30,000 | .0050 | | |
| 35,000 | .0068 | | |
| 5,000 | | .0020 | |
| 40,000 | .0080 | | |
| 45,000 | .0100 | | |
| 50,000 | .0121 | | |
| 55,000 | .0142 | | |
| 60,000 | .0170 | | Joint opened perceptibly. |
| 65,000 | .0200 | | |
| 70,000 | .0240 | | |
| 75,000 | .0285 | | Joint open ".01. |
| 80,000 | .0330 | | |
| 85,000 | .0389 | | |
| 90,000 | .0440 | | Joint open ".02. |
| 95,000 | .0508 | | |
| 100,000 | .0580 | | Joint open ".03. |
| 105,000 | .0678 | | |
| 110,000 | .0830 | | Joint open ".06. Scale started off plates. |
| 146,700 | | | Ultimate strength. |

Fractured upper plate along line of rivet holes; silky fractures; metal drew down well, and fractured in each section at the same time.

*Maximum loads on joint.*

| | Pounds per sq. inch. |
|---|---|
| Tensile strain on gross section of plate | 39,020 |
| Tensile strain on net section of plate | 62,800 |
| Compressive strain on bearing surface of rivets | 50,760 |
| Shearing strain on rivets | 32,310 |

## No. 59.—$\frac{3}{8}$" Steel Plate. Joint F . .




$\frac{11}{16}$" iron rivets, "Burden's best."
Punched holes: Punch, ".753 diameter; die, ".774 diameter.

| | Square inches. |
|---|---|
| Gross sectional area of upper plate | 3.73 |
| Net sectional area of upper plate | 2.31 |
| Bearing surface of rivets | 2.85 |
| Shearing area of rivets (".76 diameter) | 4.54 |

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| Loads applied. | Elongation in 10 inches. | Permanent set. | Remarks. |
|---|---|---|---|
| *Pounds.* | *Inch.* | *Inch.* | |
| 5,000 | 0. | ..... | |
| 10,000 | .0008 | ..... | |
| 20,000 | .0015 | ..... | |
| 30,000 | .0025 | ..... | |
| 40,000 | .0042 | ..... | |
| 50,000 | .0069 | ..... | |
| 5,000 | ..... | .0009 | |
| 55,000 | .0081 | ..... | |
| 60,000 | .0100 | ..... | |
| 65,000 | .0118 | ..... | |
| 70,000 | .0140 | ..... | |
| 5,000 | ..... | .0040 | |
| 75,000 | .0168 | ..... | Joint opened perceptibly. |
| 80,000 | .0205 | ..... | |
| 85,000 | .0250 | ..... | |
| 90,000 | .0310 | ..... | Joint open ".01. |
| 95,000 | .0370 | ..... | |
| 100,000 | .0430 | ..... | |
| 105,000 | .0505 | ..... | Joint open ".03. |
| 110,000 | .0590 | ..... | |
| 5,000 | ..... | .0430 | |
| 149,500 | ..... | ..... | Ultimate strength. |

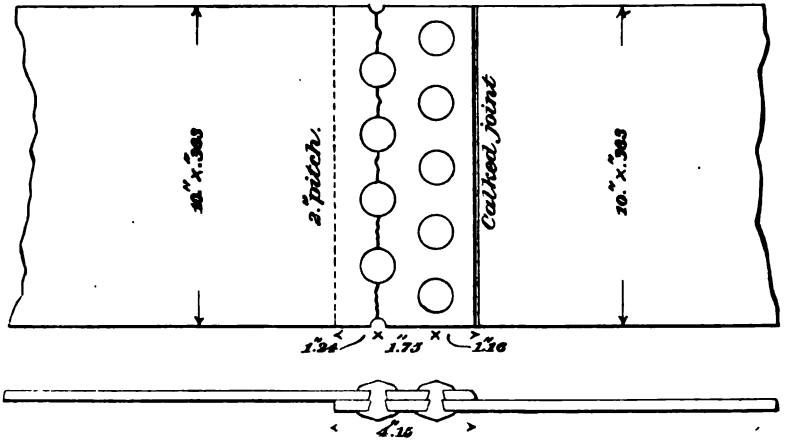
Fractured upper plate. Silky fractures.

*Maximum loads on joint.*

| | Pounds per sq. inch. |
|---|---|
| Tensile strain on gross section of upper plate | 40,080 |
| Tensile strain on net section of upper plate | 64,720 |
| Compressive strain on bearing surface of rivets | 52,450 |
| Shearing strain on rivets | 32,930 |

Photograph showing eccentricity of rivet heads, Joint No. 59.

## No. 60.—⅜" Steel Plate. Joint G.




$\frac{11}{16}$" iron rivets, "Burden's best."
Punched holes: Punch, ".753 diameter; die, ".774 diameter.

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| | Square inches. |
|---|---|
| Gross sectional area of plate | 3.63 |
| Net sectional area of plate | 2.24 |
| Bearing surface of rivets | 2.49 |
| Shearing area of rivets (".76 diameter) | 4.08 |

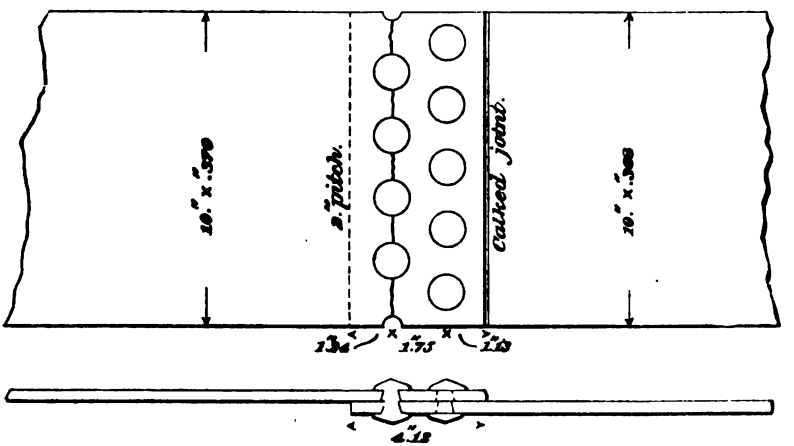
| Loads applied. | Elongation in 10 inches. | Permanent set. | Remarks. |
|---|---|---|---|
| *Pounds.* | *Inch.* | *Inch.* | |
| 5,000 | 0. | | |
| 10,000 | .0008 | | |
| 20,000 | .0020 | | |
| 30,000 | .0040 | | |
| 40,000 | .0068 | | |
| 50,000 | .0108 | | |
| 5,000 | | .0029 | |
| 60,000 | .0160 | | |
| 65,000 | .0190 | | |
| 70,000 | .0231 | | |
| 5,000 | | .0106 | |
| 75,000 | .0280 | | Joint open perceptibly. |
| 80,000 | .0339 | | Joint open ".01. |
| 85,000 | .0398 | | |
| 90,000 | .0460 | | Joint open ".02. |
| 5,000 | | .0300 | |
| 95,000 | .0540 | | Joint open ".03. |
| 100,000 | .0668 | | |
| 105,000 | .0778 | | Joint open ".05. |
| 110,000 | .0929 | | |
| 115,000 | .1098 | | |
| 141,600 | | | Ultimate strength. |

Fractured upper plate along line of rivet holes; silky fractures; metal hard about holes, with small granular spots near punched holes.

*Maximum loads on joint.*

| | Pounds per sq. inch. |
|---|---|
| Tensile strain on gross section of plate | 39,010 |
| Tensile strain on net section of plate | 63,210 |
| Compressive strain on bearing surface of rivets | 56,860 |
| Shearing strain on rivets | 34,710 |

## No. 61.—$\frac{3}{8}$" Steel Plate. Joint G . .




$\frac{11}{16}$" iron rivets, "Burden's best."
Punched holes: Punch, ".753 diameter; die, ".774 diameter.

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| | Square inches. |
|---|---|
| Gross sectional area of upper plate | 3.70 |
| Net sectional area of upper plate | 2.29 |
| Bearing surface of rivets | 2.54 |
| Shearing area of rivets (".76 diameter) | 4.08 |

| Loads applied. | Elongation in 10 inches. | Permanent set. | Remarks. |
|---|---|---|---|
| *Pounds.* | *Inch.* | *Inch.* | |
| 5,000 | .0 | | |
| 10,000 | .0005 | | |
| 20,000 | .0013 | | |
| 30,000 | .0028 | | |
| 40,000 | .0046 | | |
| 50,000 | .0079 | | |
| 5,000 | | .0021 | |
| 60,000 | .0122 | | |
| 65,000 | .0150 | | |
| 70,000 | .0180 | | |
| 5,000 | | .0085 | |
| 75,000 | .0238 | | Joint opened perceptibly. |
| 80,000 | .0288 | | Joint open ".01. |
| 85,000 | .0340 | | Joint open ".02. |
| 90,000 | .0405 | | Joint open ".03. |
| 5,000 | | .0271 | Joint open ".01+. |
| 95,000 | .0480 | | Joint open ".04. |
| 100,000 | .0605 | | Joint open ".05. |
| 105,000 | .0720 | | |
| 110,000 | | | Approximately the elastic limit of the plate = 29,730 pounds per square inch. |
| 125,800 | | | Ultimate strength. Fractured plate. |

Sharp but not loud report heard at 100,000 pounds and again heard just before fracture of the plate.

Fractured plate across row of four rivet holes; the metal first separated at the middle sections, which displayed in part fine granular fractures and in part silky appearance.

*Maximum loads on joint.*

| | Pounds per sq. inch. |
|---|---|
| Tensile strain on gross section of upper plate | 34,000 |
| Tensile strain on net section of upper plate | 54,930 |
| Compressive strain on bearing surface of rivets | 49,530 |
| Shearing strain on rivet | 30,530 |

Photograph of fractured plate, showing granular metal, next two rivet holes, radiating from rivet holes.

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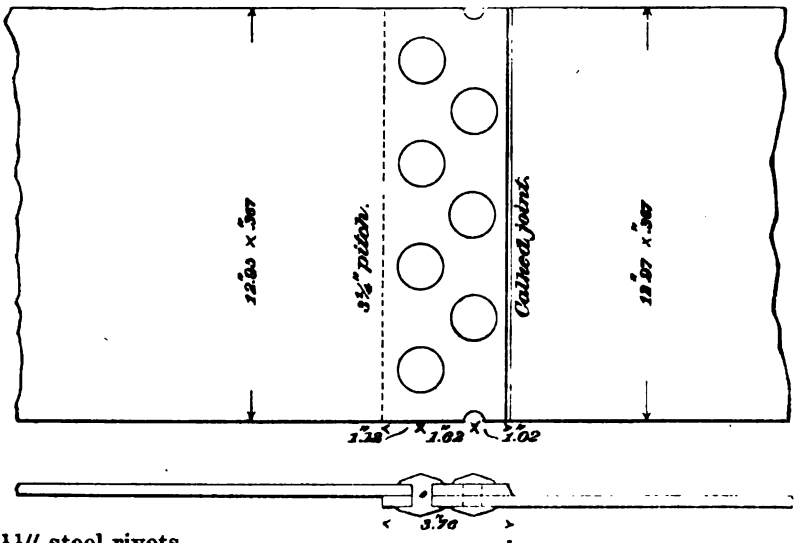
## No. 83.—$\frac{3}{8}$″ Steel Plate. Joint I.




$\frac{11}{16}$″ steel rivets.
Drilled holes, ″.75 diameter.

| | Square inches. |
|---|---|
| Gross sectional area of upper plate | 4.75 |
| Net sectional area of upper plate | 3.65 |
| Bearing surface of rivets | 1.93 |
| Shearing area of rivets (″.75 diameter) | 3.09 |

| Loads applied. | Elongation in 10 inches. | Permanent set. | Remarks. |
|---|---|---|---|
| *Pounds.* | *Inch.* | *Inch.* | |
| 5,000 | 0. | | |
| 10,000 | 0. | | |
| 20,000 | .0011 | | |
| 30,000 | .0029 | | |
| 40,000 | .0055 | | |
| 50,000 | .0090 | | |
| 60,000 | .0145 | | |
| 65,000 | .0170 | | |
| 5,000 | | .0079 | |
| 70,000 | .0200 | | |
| 75,000 | .0230 | | |
| 80,000 | .0260 | | Joint started perceptibly. |
| 85,000 | .0309 | | |
| 90,000 | .0340 | | Joint open ″.01. |
| 95,000 | .0408 | | |
| 100,000 | .0528 | | Joint open ″.03. |
| 105,000 | .0620 | | Joint open ″.05. |
| 110,000 | .0708 | | |
| 115,000 | .0815 | | |
| 120,000 | .0945 | | |
| 125,000 | .1085 | | |
| 130,000 | .1220 | | |
| 163,000 | | | Ultimate strength. Sheared rivets. |

Average elongation of holes, ″.13 each.

*Maximum loads on joint.*

| | Pounds per sq. inch. |
|---|---|
| Tensile strain on gross section of plate | 34,316 |
| Tensile strain on net section of plate | 44,660 |
| Compressive strain on bearing surface of rivets | 84,460 |
| Shearing strain on rivets | 52,750 |

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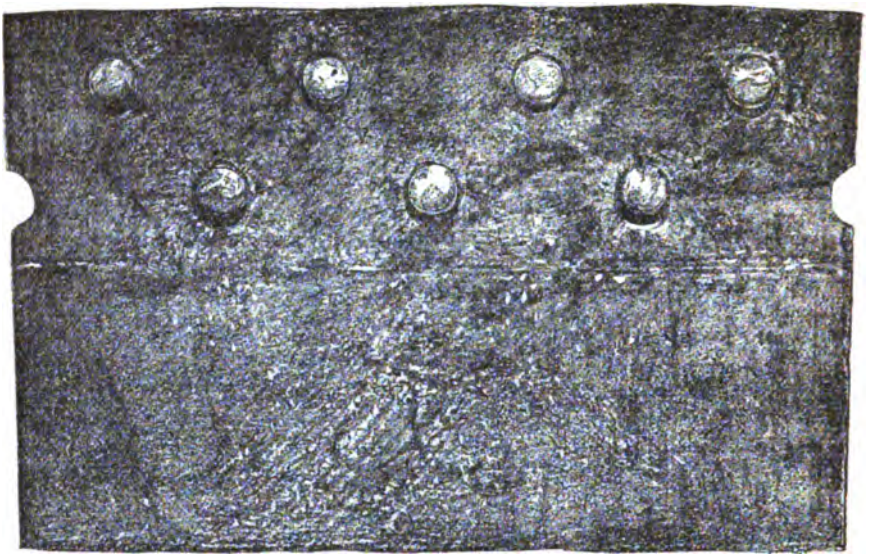

Photograph of under plate, Joint No. 83. Appearance after rivets were sheared, showing the development of "Cooper lines."

## No. 84.—$\frac{3}{8}$″ Steel Plate. Joint I . .

Same style of joint as No. 83.
Upper plate, 12″.96 × ″.368.
Under plate, 12″.96 × ″.370.
$\frac{11}{16}$″ steel rivets.
Drilled holes, ″.75.

| | Square inches. |
|---|---|
| Gross sectional area of upper plate | 4.77 |
| Net sectional area of upper plate | 3.67 |
| Bearing surface of rivets | 1.93 |
| Shearing area of rivets (″.75 diameter) | 3.09 |

| Loads applied. | Elongation in 10 inches. | Permanent set. | Remarks. |
|---|---|---|---|
| *Pounds.* | *Inch.* | *Inch.* | |
| 5,000 | 0. | | |
| 10,000 | 0. | | |
| 20,000 | .0008 | | |
| 30,000 | .0018 | | |
| 40,000 | .0039 | | |
| 50,000 | .0070 | | |
| 55,000 | .0090 | | |
| 60,000 | .0108 | | |
| 65,000 | .0121 | | |
| 5,000 | | .0061 | |
| 70,000 | .0140 | | |
| 75,000 | .0160 | | |
| 80,000 | .0192 | | |
| 85,000 | .0225 | | |
| 90,000 | .0270 | | Joint opened perceptibly. |
| 95,000 | .0330 | | Joint open ″.01. |
| 100,000 | .0425 | | |
| 105,000 | .0515 | | Joint open ″.02. |
| 110,000 | .0628 | | Joint open ″.03. |
| 115,000 | .0700 | | Joint open ″.04. |
| 120,000 | .0830 | | Joint open ″.05. |
| 160,200 | | | Ultimate strength. Sheared rivets. |

Average elongation of rivet holes, ″.13 each.

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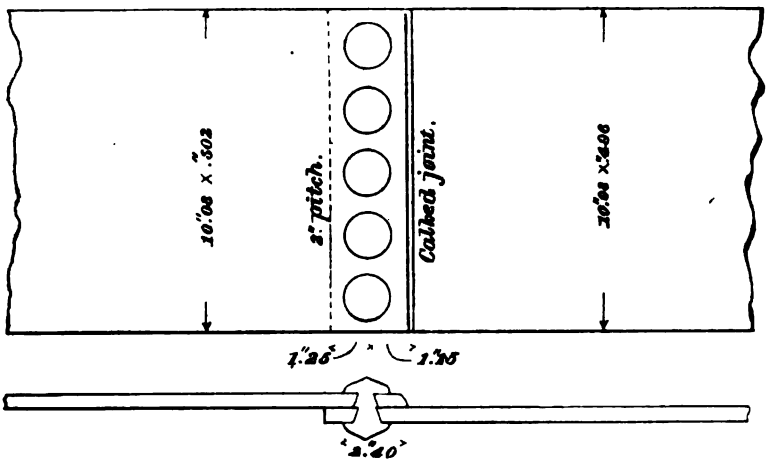
*Maximum loads on joint.*

| | Pounds per sq. inch. |
|---|---|
| Tensile strength on gross section of plate | 33,585 |
| Tensile strength on net section of plate | 43,650 |
| Compressive strain on bearing surface of rivets | 83,000 |
| Shearing strain on rivets | 83,000 |

SINGLE AND DOUBLE RIVETED LAP JOINTS, ¼" STEEL PLATE.

No. 242.—½" STEEL PLATE. JOINT A.




¾" iron rivets, "Burden's best."
Punched holes: Punch, $\frac{15}{16}$" diameter; die, $\frac{15}{16}$" diameter.

| | Square inches. |
|---|---|
| Gross sectional area of under plate | 4.97 |
| Net sectional area of under plate | 2.84 |
| Bearing surface of rivets | 2.13 |
| Shearing area of rivets (".82 diameter) | 2.64 |

| Loads applied. | Elongation in 10 inches. | Permanent set. | Remarks. |
|---|---|---|---|
| *Pounds.* | *Inch.* | *Inch.* | |
| 5,000 | 0. | ..... | |
| 10,000 | .0009 | ..... | |
| 20,000 | .0020 | ..... | |
| 30,000 | .0042 | ..... | |
| 35,000 | .0068 | ..... | |
| 5,000 | ..... | .0025 | |
| 10,000 | .0030 | ..... | |
| 20,000 | .0045 | ..... | |
| 30,000 | .0060 | ..... | |
| 35,000 | .0068 | ..... | |
| 5,000 | ..... | .0025 | |
| 40,000 | .0095 | ..... | |
| 45,000 | .0125 | ..... | |
| 50,000 | .0160 | ..... | |
| 5,000 | ..... | .0080 | |
| 10,000 | .0088 | ..... | |
| 20,000 | .0102 | ..... | |
| 30,000 | .0120 | ..... | |
| 40,000 | .0141 | ..... | |
| 50,000 | .0168 | ..... | |
| 55,000 | .0190 | ..... | |
| 60,000 | .0225 | ..... | Joint opened perceptibly. |
| 65,000 | .0280 | ..... | |
| 70,000 | .0360 | ..... | |
| 75,000 | .0462 | ..... | Joint open ".01. |
| 80,000 | .0590 | ..... | |
| 85,000 | .0760 | ..... | Joint open ".02½. |
| 90,000 | .097 | ..... | |
| 100,000 | ..... | ..... | Micrometer removed. |
| 108,500 | ..... | ..... | Ultimate strength. Sheared rivets. |

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Failure took place immediately after the first warning that the rivets were yielding.

Elongation of rivet holes from ".04 to ".06.

*Maximum loads on joint.*

| | Pounds per sq. inch. |
|---|---|
| Tensile strain on gross section of plate | 21,830 |
| Tensile strain on net section of plate | 38,204 |
| Compressive strain on bearing surface of rivets | 50,940 |
| Shearing strain on rivets | 41,100 |

## No. 243.—½" STEEL PLATE. JOINT A.

Same style of joint as No. 242.
Under plate, 10".04 × ".500.
Under plate, 10".04 × ".495.
¾" iron rivets, "Burden's best."
Punched holes: Punch, $\frac{13}{16}$" diameter; $\frac{13}{32}$" diameter of die.

| | Square inches. |
|---|---|
| Gross sectional area of under plate | 4.97 |
| Net sectional area of under plate | 2.84 |
| Bearing surface of rivets | 2.13 |
| Shearing area of rivets (".82 diameter) | 2.64 |

| Loads applied. | Elongation in 10 inches. | Permanent set. | Remarks. |
|---|---|---|---|
| *Pounds.* | *Inch.* | *Inch.* | |
| 5,000 | 0. | | |
| 10,000 | .0008 | | |
| 20,000 | .0020 | | |
| 30,000 | .0035 | | |
| 35,000 | .0050 | | |
| 5,000 | | .0012 | |
| 40,000 | .0080 | | |
| 45,000 | .0118 | | |
| 50,000 | .0150 | | |
| 5,000 | | .0068 | |
| 55,000 | .0180 | | |
| 60,000 | .0220 | | |
| 65,000 | .0300 | | Joint opened perceptibly. |
| 70,000 | .0395 | | |
| 75,000 | .0500 | | Joint open ".01. |
| 80,000 | .0630 | | |
| 85,000 | .0790 | | Micrometer removed. |
| 90,000 | .11 | | |
| 95,000 | .13 | | |
| 100,000 | .16 | | |
| 102,000 | | | Ultimate strength. Sheared rivets. |

*Maximum loads on joint.*

| | Pounds per sq. inch. |
|---|---|
| Tensile strain on gross section of plate | 29,523 |
| Tensile strain on net section of plate | 35,915 |
| Compressive strain on bearing surface of rivets | 47,890 |
| Shearing strain on rivets | 38,636 |

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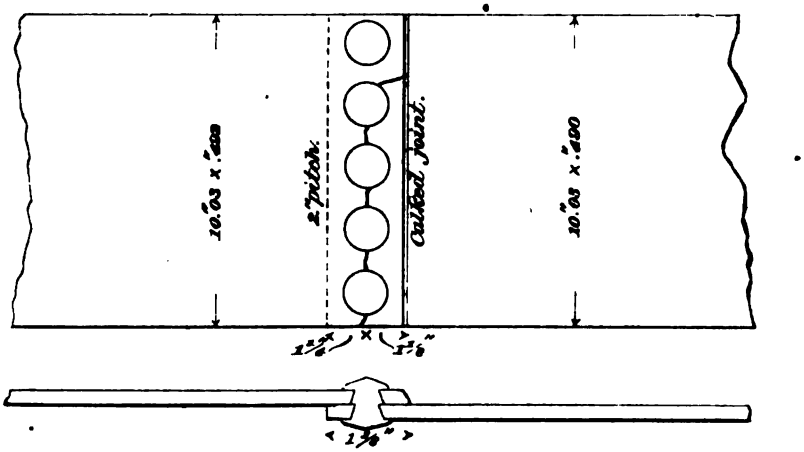
## No. 294.—½″ Steel Plate. Joint A A.




$\frac{15}{16}$″ iron rivets, "Burden's best."
Punched holes: Punch, 1″ diameter; die, $1\frac{1}{16}$″ diameter.

| | Square inches. |
|---|---|
| Gross sectional area of upper plate | 4.93 |
| Net sectional area of upper plate | 2.40 |
| Bearing surface of rivets | 2.536 |
| Shearing area of rivets (1″ diameter) | 3.93 |

| Loads applied. | Elongation in 10 inches. | Permanent set. | Remarks. |
|---|---|---|---|
| *Pounds.* | *Inch.* | *Inch.* | |
| 5,000 | 0. | | |
| 10,000 | .0006 | | |
| 20,000 | .0019 | | |
| 30,000 | .0035 | | |
| 35,000 | .0042 | | |
| 5,000 | | .0010 | |
| 40,000 | .0058 | | |
| 45,000 | .0071 | | |
| 50,000 | .0091 | | Joint started perceptibly. |
| 55,000 | .0115 | | Joint open ".01. |
| 60,000 | .0142 | | |
| 65,000 | .0170 | | |
| 70,000 | .0210 | | |
| 75,000 | .0278 | | |
| 80,000 | .0368 | | |
| 85,000 | .0445 | | |
| 90,000 | .0550 | | Joint open ".02. |
| 100,000 | .10 | | |
| 110,000 | .14 | | |
| 120,000 | .17 | | |
| 144,500 | | | Ultimate strength. |

Tore plate across four rivet holes, shearing one end rivet.

The plate failed at the commencement of fracture by parting the middle sections, which showed a granular appearance. Metal not drawn down. Two sections between rivets have silky appearance, with seam through middle. Metal drawn down.

*Maximum loads on joint.*

| | Pounds per sq. inch. |
|---|---|
| Tensile strain on gross section of upper plate | 29,310 |
| Tensile strain on net section of upper plate | 60,210 |
| Compressive strain on bearing surface of rivets | 56,980 |
| Shearing strain on rivets | 63,770 |



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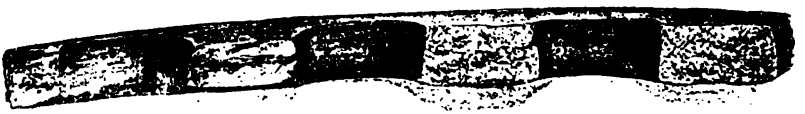
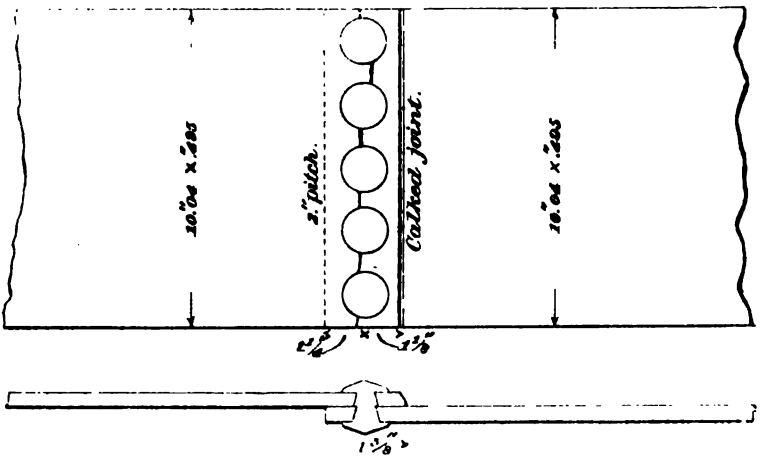


Fractured end of upper plate, Joint No. 294, showing granular and silky appearance in same metal.

## No. 295.—½″ Steel Plate. Joint A. A . .




15/16″ iron rivets, "Burden's best."
Punched holes: Punch, 1″ diameter; die, 1 1/16″ diameter.

| | Square inches. |
|---|---|
| Gross sectional area of plate | 4.97 |
| Net sectional area of plate | 2.42 |
| Bearing surface of rivets | 2.55 |
| Shearing area of rivets (1″ diameter) | 3.93 |

| Loads applied. | Elongation in 10 inches. | Permanent set. | Remarks. |
|---|---|---|---|
| *Pounds.* | *Inch.* | *Inch.* | |
| 5,000 | 0. | ..... | |
| 10,000 | .0005 | ..... | |
| 20,000 | .0018 | ..... | |
| 30,000 | .0038 | ..... | |
| 35,000 | .0050 | ..... | |
| 5,000 | ..... | .0010 | |
| 40,000 | .0068 | ..... | |
| 45,000 | .0088 | ..... | |
| 50,000 | .0110 | ..... | |
| 55,000 | .0130 | ..... | |
| 60,000 | .0165 | ..... | Joint opened perceptibly. |
| 65,000 | .0210 | ..... | |
| 70,000 | .0248 | ..... | |
| 75,000 | .0300 | ..... | |
| 80,000 | .0360 | ..... | Joint open ".01. |
| 85,000 | .0430 | ..... | |
| 90,000 | .0625 | ..... | |
| 100,000 | .10 | ..... | Sharp snapping sound heard. |
| 110,000 | .14 | ..... | Sharp snapping sound repeated at 104,500 pounds. |
| 120,000 | ..... | ..... | Ultimate strength. |

Broke suddenly across rivet holes; appearance of fracture granular; no contraction.

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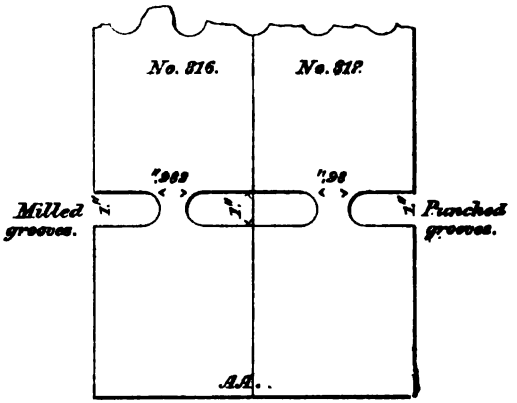
*Maximum loads on joint.*

| | Pounds per sq. inch. |
|---|---|
| Tension strain on gross section of plate | 24,145 |
| Tension strain on net section of plate | 49,590 |
| Compression strain on bearing surface of rivets | 47,060 |
| Shearing strain on rivets | 30,540 |

Photograph of fractured sections, upper plate, Joint No. 295. Granular fractures produced in the lap oint.



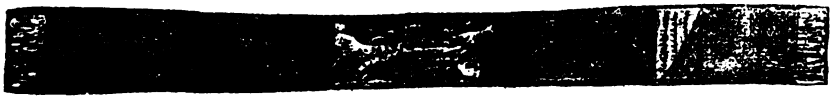

Specimens cut out of fractured plate A A . . No. 295. Tested by direct tension.

Sheet cut in two at middle.
One-half prepared with milled grooves.
One-half prepared with punched grooves.

No. 316.—MILLED SPECIMEN.

Sectional area, ″.982×″.495 = .486 square inch.
Ultimate strength, 32,850 pounds = 67,600 pounds per square inch.
Area at fracture, ″.88×″.33 = .290 square inch.
Contraction of area, 40.3 per cent.
Silky fracture; spongy line through center.

No. 317.—PUNCHED SPECIMEN.



Sectional area, ″.98×″.501 = .49 square inch.
Ultimate strength, 32,790 pounds = 66,920 pounds per square inch.
Area at fracture, ″.92×″.36 = .33 square inch.
Contraction of area, 32.7 per cent.
Appearance of fracture, silky, with slight granular appearance at center.

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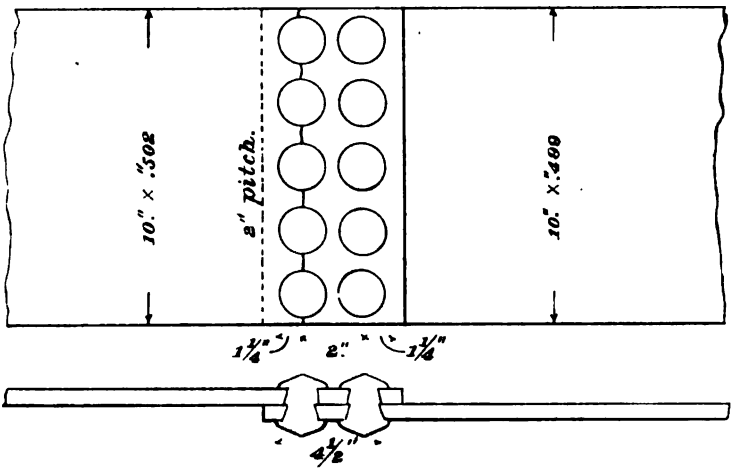
## No. 619.—½″ Steel Plate. Plates C.




$\frac{15}{16}$″ iron rivets, "Burden's best."
Punched holes: Punch, 1″ diameter; die, $1\frac{3}{32}$″ diameter.

| | Square inches. |
|---|---|
| Gross sectional area of upper plate | 5.02 |
| Net sectional area of upper plate | 2.39 |
| Bearing surface of rivets | 5.26 |
| Shearing area of rivets | 7.85 |

| Loads applied. | Elongation in 10 inches. | Permanent set. | Remarks. |
|---|---|---|---|
| *Pounds.* | *Inch.* | *Inch.* | |
| 5,000 | 0. | | |
| 10,000 | .0005 | | |
| 20,000 | .0020 | | |
| 30,000 | .0040 | | |
| 35,000 | .0052 | | |
| 5,000 | | .0019 | |
| 40,000 | .0068 | | |
| 45,000 | .0080 | | |
| 50,000 | .0098 | | |
| 5,000 | | .0045 | |
| 55,000 | .0120 | | |
| 60,000 | .0140 | | |
| 65,000 | .0166 | | |
| 70,000 | .0190 | | |
| 5,000 | | .0110 | Micrometer removed. |
| 75,000 | .035 | | Elongations measured with dividers. |
| 80,000 | .035 | | |
| 85,000 | .04 | | |
| 90,000 | .05 | | |
| 95,000 | .05 | | |
| 100,000 | .06 | | |
| 105,000 | .06 | | |
| 110,000 | .07 | | |
| 115,000 | .07 | | |
| 120,000 | .07 | | |
| 125,000 | .08 | | |
| 130,000 | .085 | | |
| 154,400 | | | Ultimate strength. |

Fractured upper plate across line of rivet holes.

Five of the fractured sections broke suddenly, with granular appearance and without contraction of area.

The sixth end section had silky appearance, the metal drawing down before breaking.

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*Maximum loads on joint.*

| | Pounds per sq. inch. |
|---|---|
| Tensile strain on gross section of upper plate | 30,757 |
| Tensile strain on net section of upper plate | 64,602 |
| Compressive strain on bearing surface of rivets | 29,354 |
| Shearing strain on rivets | 19,670 |

## No. 620.—½″ Steel Plate. Plates C . .

## (Duplicate of C .)

Same style of joint as No. 619.
Upper plate, 10″ × ″.501.
Under plate, 10″ × ″.502.
$\frac{15}{16}$″ iron rivets, "Burden's best."
Punched holes: Punch, 1″ diameter; die, $1\frac{3}{32}$″ diameter.

| | Square inches. |
|---|---|
| Gross sectional area of upper plate | 5.01 |
| Net sectional area of upper plate | 2.39 |
| Bearing surface of rivets | 5.25 |
| Shearing area of rivets | 7.85 |

| Loads applied. | Elongation in 10 inches. | Permanent set. | Remarks. |
|---|---|---|---|
| *Pounds.* | *Inch.* | *Inch.* | |
| 5,000 | 0. | | |
| 10,000 | .0005 | | |
| 20,000 | .0018 | | |
| 30,000 | .0035 | | |
| 35,000 | .0048 | | |
| 5,000 | | .0012 | |
| 40,000 | .0060 | | |
| 45,000 | .0070 | | |
| 50,000 | .0089 | | |
| 5,000 | | .0030 | |
| 55,000 | .0108 | | |
| 60,000 | .0125 | | |
| 65,000 | .0148 | | |
| 70,000 | .0162 | | |
| 5,000 | | .0090 | |
| 75,000 | .0198 | | |
| 80,000 | .0230 | | |
| 85,000 | .0268 | | |
| 90,000 | .0305 | | |
| 95,000 | .0348 | | |
| 100,000 | .0390 | | |
| 5,000 | | .0268 | Micrometer removed. |
| 105,000 | .07— | | |
| 110,000 | .07— | | |
| 115,000 | .07— | | |
| 120,000 | .07+ | | |
| 130,000 | .08 | | |
| 140,000 | .10 | | |
| 150,000 | .14 | | |
| 154,200 | | | Ultimate strength. |

Fractured upper plate across line of rivet holes.
Broke suddenly, fractures granular. No contraction of area.

*Maximum loads on joint.*

| | Pounds per sq. inch. |
|---|---|
| Tensile strain on gross section of upper plate | 30,778 |
| Tensile strain on net section of upper plate | 64,519 |
| Compressive strain on bearing surface of rivets | 29,371 |
| Shearing strain on rivets | 19,644 |

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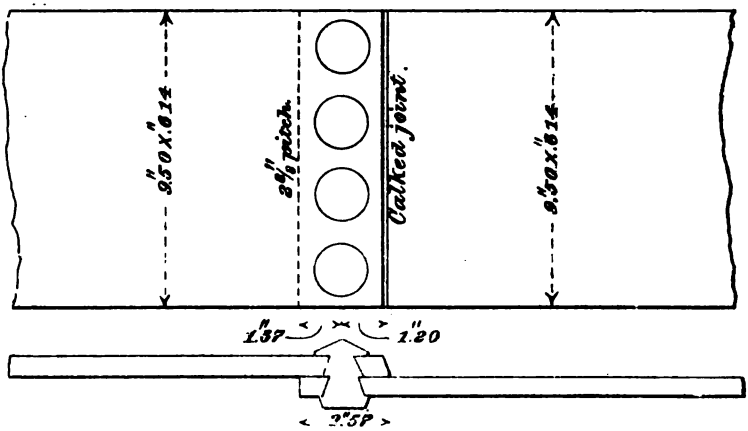
SINGLE AND DOUBLE RIVETED LAP JOINTS, $\frac{5}{8}$" STEEL PLATE.

No. 734.—$\frac{5}{8}$" STEEL PLATE. SET A.




1" steel rivets, hand-driven.
Punched holes: Punch, $1\frac{1}{16}$" diameter; die, $1\frac{5}{32}$" diameter.

| | Square inches. |
|---|---|
| Gross sectional area of plate | 5.83 |
| Net sectional area of plate | 3.11 |
| Bearing surface of rivets | 2.72 |
| Shearing area of rivets | 3.55 |

| Loads applied. | Elongation in 10 inches. | Permanent set. | Remarks. |
|---|---|---|---|
| *Pounds.* | *Inch.* | *Inch.* | |
| 5,000 | 0. | | |
| 10,000 | .0008 | | |
| 20,000 | .0018 | | |
| 30,000 | .0035 | | |
| 40,000 | .0068 | | |
| 50,000 | .0108 | | |
| 60,000 | .0160 | | |
| 65,000 | .0188 | | |
| 70,000 | .0225 | | |
| 75,000 | .0280 | | |
| 80,000 | .0348 | | |
| 85,000 | .0455 | | |
| 90,000 | .0600 | | |
| 100,000 | .09 | | |
| 110,000 | .14 | | |
| 120,000 | .17 | | |
| 130,000 | .22 | | Slight snapping sound at 132,000 pounds. |
| 140,000 | | | |
| 154,400 | | | Ultimate strength. |

Sheared rivets.
Average elongation of rivet holes, ".15.

*Maximum loads on joint.*

| | Pounds per sq. inch. |
|---|---|
| Tensile strain on gross section of plate | 26,480 |
| Tensile strain on net section of plate | 49,650 |
| Compressive strain on bearing surface of rivets | 56,760 |
| Shearing strain on rivets | 43,490 |

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## No. 735.—⅝″ STEEL PLATE. SET A . .

### Duplicate of A . No. 734.

Upper plate, 9″.50 × ″.617.
Under plate, 9″.50 × ″.613.
1″ steel rivets, hand-driven.
Punched holes: Punch, $1\frac{1}{16}$″ diameter; die, $1\frac{5}{32}$″ diameter.

| | Square inches. |
|---|---|
| Gross sectional area of under plate | 5.82 |
| Net sectional area of under plate | 3.10 |
| Bearing surface of rivets | 2.72 |
| Shearing area of rivets | 3.55 |

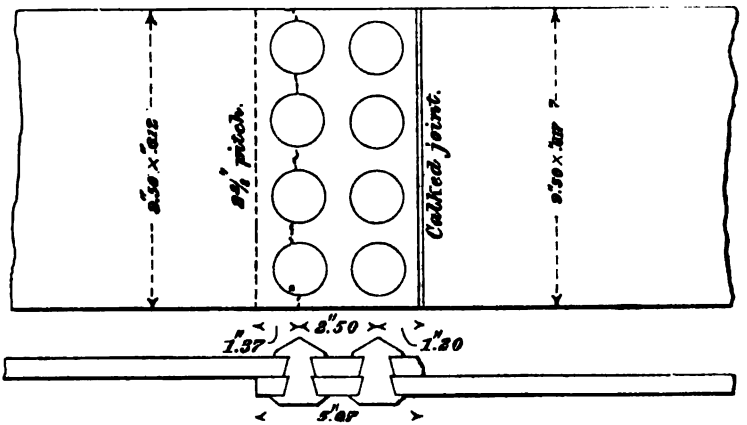
| Loads applied. | Elongation in 10 inches. | Permanent set. | Remarks. |
|---|---|---|---|
| *Pounds.* | *Inch.* | *Inch.* | |
| 5,000 | 0. | | |
| 10,000 | .0008 | | |
| 20,000 | .0018 | | |
| 30,000 | .0031 | | |
| 35,000 | .0040 | | |
| 40,000 | .0050 | | |
| 45,000 | .0066 | | |
| 50,000 | .0082 | | |
| 55,000 | .0105 | | |
| 60,000 | .0128 | | |
| 65,000 | .0152 | | |
| 70,000 | .0185 | | |
| 75,000 | .0220 | | |
| 80,000 | .0280 | | |
| 85,000 | .0370 | | |
| 90,000 | .0570 | | |
| 100,000 | .09 | | |
| 110,000 | .18 | | |
| 140,000 | .28 | | |
| 163,600 | | | Ultimate strength. |

Sheared rivets.
Average elongation of rivet holes, ″.11.

*Maximum loads on joint.*

| | Pounds per sq. inch. |
|---|---|
| Tensile strain on gross section of under plate | 28,110 |
| Tensile strain on net section of under plate | 52,770 |
| Compressive strain on bearing surface of rivets | 60,150 |
| Shearing strain on rivets | 46,080 |

## No. 736.—⅝″ STEEL PLATE. SET C .




1″ steel rivets, hand-driven.
Punched holes: Punch, $1\frac{1}{16}$″ diameter; die, $1\frac{5}{32}$″ diameter.

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| | Square inches. |
|---|---|
| Gross sectional area of upper plate | 5.81 |
| Net sectional area of upper plate | 3.10 |
| Bearing surface of rivets | 5.43 |
| Shearing area of rivets | 7.09 |

| Loads applied. | Elongation in 10 inches. | Permanent set. | Remarks. |
|---|---|---|---|
| *Pounds.* | *Inch.* | *Inch.* | |
| 5,000 | 0. | | |
| 10,000 | .0006 | | |
| 20,000 | .0018 | | |
| 30,000 | .0030 | | |
| 40,000 | .0058 | | |
| 50,000 | .0080 | | |
| 60,000 | .0120 | | |
| 65,000 | .0148 | | |
| 70,000 | .0175 | | |
| 75,000 | .0208 | | |
| 80,000 | .0240 | | |
| 85,000 | .0275 | | |
| 90,000 | .0309 | | |
| 95,000 | .0338 | | |
| 100,000 | .0370 | | |
| 105,000 | .0405 | | |
| 110,000 | .0440 | | |
| 115,000 | .0488 | | |
| 120,000 | .0540 | | |
| 140,000 | .08 | | |
| 160,000 | .14 | | |
| 190,000 | .29 | | |
| 216,000 | | | Ultimate strength. |

*Maximum loads on joint.*

| | Pounds per sq. inch. |
|---|---|
| Tensile strain on gross section of upper plate | 37,180 |
| Tensile strain on net section of upper plate | 69,680 |
| Compressive strain on bearing surface of rivets | 39,780 |
| Shearing strain on rivets | 30,470 |

## No. 737.—$\frac{5}{8}$″ Steel Plate. Set C . .

Duplicate of C . No. 736.
Upper plate, 9″.50 × ″.612.
Under plate, 9″.50 × ″.616.
1″ steel rivets, hand-driven.
Punched holes: Punch, $1\frac{1}{16}$″ diameter; die, $1\frac{5}{33}$″ diameter.

| | Square inches. |
|---|---|
| Gross sectional area of upper plate | 5.81 |
| Net sectional area of upper plate | 3.10 |
| Bearing surface of rivets | 5.43 |
| Shearing area of rivets | 7.09 |

| Loads applied. | Elongation in 10 inches. | Permanent set. | Remarks. |
|---|---|---|---|
| *Pounds.* | *Inch.* | *Inch.* | |
| 5,000 | 0. | | |
| 10,000 | .0008 | | |
| 20,000 | .0021 | | |
| 30,000 | .0040 | | |
| 40,000 | .0068 | | |
| 50,000 | .0102 | | |
| 60,000 | .0150 | | |
| 70,000 | .0220 | | |
| 80,000 | .0280 | | |
| 90,000 | .0340 | | |
| 100,000 | .0420 | | |
| 110,000 | .0480 | | |
| 130,000 | .07 | | |
| 160,000 | .14 | | |
| 175,000 | | | Snapping sound heard. |
| 208,000 | | | Ultimate strength. |

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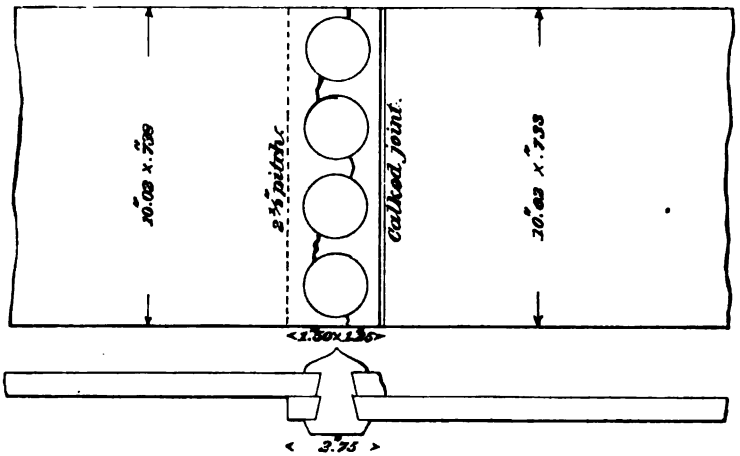
Fractured upper plate across line of rivet holes.
Fracture granular, radiating from rivet holes; metal not drawn down.

*Maximum loads on joint.*

| | Pounds per sq. inch. |
|---|---|
| Tensile strain on gross section of upper plate | 35,800 |
| Tensile strain on net section of upper plate | 67,100 |
| Compressive strain on bearing surface of rivets | 38,300 |
| Shearing strain on rivets | 29,340 |

SINGLE AND DOUBLE RIVETED LAP JOINTS, ¼″ STEEL PLATE.

No. 726.—¾″ STEEL PLATE. SET A.




1⅛″ steel rivets, hand-driven.
Punched holes: Punch, 1 3/16″ diameter; die, 1 3/32 diameter.

| | Square inches. |
|---|---|
| Gross sectional area of upper plate | 7.39 |
| Net sectional area of upper plate | 3.75 |
| Bearing surface of rivets | 3.64 |
| Shearing area of rivets | 4.43 |

| Loads applied. | Elongation in 10 inches. | Permanent set. | Remarks. |
|---|---|---|---|
| *Pounds.* | *Inch.* | *Inch.* | |
| 5,000 | 0. | | |
| 10,000 | .0002 | | |
| 20,000 | .0009 | | |
| 30,000 | .0020 | | |
| 40,000 | .0038 | | |
| 50,000 | .0090 | | |
| 55,000 | .0120 | | |
| 60,000 | .0150 | | |
| 65,000 | .0185 | | |
| 70,000 | .0220 | | |
| 75,000 | .0255 | | |
| 90,000 | .05 | | |
| 100,000 | .06 | | |
| 110,000 | .09 | | |
| 120,000 | .14 | | |
| 130,000 | .16 | | Sharp snapping sound heard. |
| 140,000 | .21 | | |
| 149,900 | | | Ultimate strength. |

Fractured upper plate. Appearance of fractures granular, radiating from rivet holes without contraction of area except end section *A*, which is silky, and metal well drawn down.
Broke suddenly with loud report.
Lower plate bent to an angle of about 11°.

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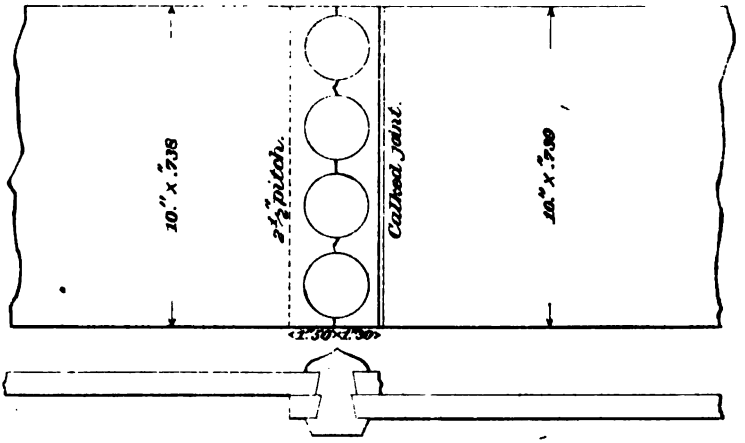
*Maximum loads on joint.*

| | Pounds per sq. inch. |
|---|---|
| Tensile strain on gross section of upper plate | 20,280 |
| Tensile strain on net section of upper plate | 39,970 |
| Compressive strain on bearing surface of rivets | 41,180 |
| Shearing strain on rivets | 33,840 |

## No. 727.—¾″ Steel Plate. Set A..




1⅛″ steel rivets, hand-driven.
Punched holes: Punch, 1 3/16″ diameter; die, 1 9/32″ diameter.

| | Square inches. |
|---|---|
| Gross sectional area of upper plate | 7.38 |
| Net sectional area of upper plate | 3.73 |
| Bearing surface of rivets | 3.64 |
| Shearing area of rivets | 4.43 |

| Loads applied. | Elongation in 10 inches. | Permanent set. | Remarks. |
|---|---|---|---|
| *Pounds.* | *Inch.* | *Inch.* | |
| 5,000 | 0. | | |
| 10,000 | .0001 | | |
| 20,000 | .0010 | | |
| 30,000 | .0022 | | |
| 35,000 | .0030 | | |
| 40,000 | .0040 | | |
| 45,000 | .0052 | | |
| 50,000 | .0072 | | |
| 55,000 | .0100 | | |
| 60,000 | .0128 | | |
| 65,000 | .0160 | | |
| 70,000 | .0190 | | |
| 75,000 | .0225 | | |
| 80,000 | .0260 | | |
| 85,000 | .0310 | | |
| 90,000 | .0360 | | |
| 95,000 | .0415 | | |
| 100,000 | .0500 | | |
| 110,000 | .09 | | |
| 120,000 | .11 | | |
| 130,000 | .15 | | |
| 140,000 | .20 | | |
| 176,700 | | | Ultimate strength. |

Fractured upper plate. Broke suddenly with loud report. Metal granular.
No contraction of area.

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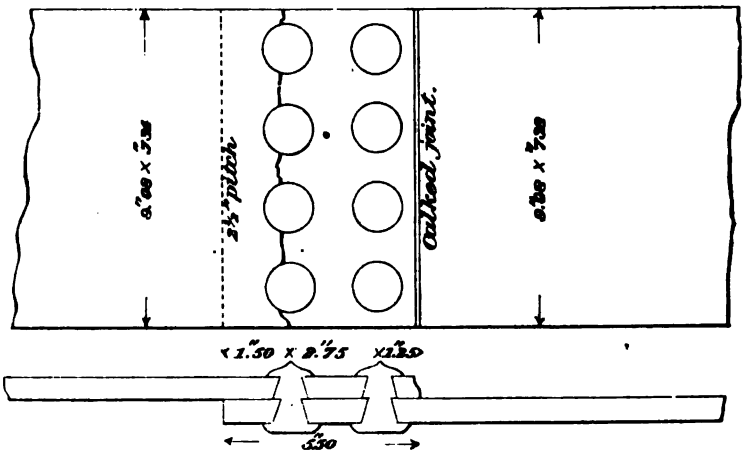
*Maximum loads on joint.*

| | Pounds per sq. inch. |
|---|---|
| Tensile strain on gross section of upper plate | 23,940 |
| Tensile strain on net section of upper plate | 47,370 |
| Compressive strain on bearing surface of rivets | 48,540 |
| Shearing strain on rivets | 39,890 |

## No. 728.—¾″ Steel Plate. Set C.




1⅛″ steel rivets, hand-driven.

Punched holes: Punch, 1 3/16″ diameter; die, 1 3/32 diameter.

| | Square inches. |
|---|---|
| Gross sectional area of upper plate | 7.83 |
| Net sectional area of upper plate | 3.70 |
| Bearing surface of rivets | 7.25 |
| Shearing area of rivets | 8.86 |

| Loads applied. | Elongation in 10 inches. | Permanent set. | Remarks. |
|---|---|---|---|
| *Pounds.* | *Inch.* | *Inch.* | |
| 5,000 | 0. | | |
| 10,000 | .0002 | | |
| 20,000 | .0011 | | |
| 30,000 | .0025 | | |
| 40,000 | .0040 | | |
| 50,000 | .0062 | | |
| 60,000 | .0092 | | |
| 65,000 | .0116 | | |
| 70,000 | .0135 | | |
| 75,000 | .0160 | | |
| 80,000 | .0182 | | |
| 85,000 | .0208 | | |
| 90,000 | .0240 | | |
| 95,000 | .0268 | | Joint open ".01. |
| 100,000 | .0300 | | |
| 120,000 | .04 | | |
| 140,000 | .06 | | |
| 160,000 | .08 | | Snapping sound. |
| 181,200 | | | Ultimate strength. |

Fractured upper plate, granular fractures radiating from rivet holes; hard appearance of metal next punched holes; metal not drawn down; exception, one end section has silky appearance, with metal well drawn down. Broke suddenly with loud report.

Lower plate bent about 5°.

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*Maximum loads on joint.*

| | Pounds per sq. inch. |
|---|---|
| Tensile strain on gross section of upper plate | 24,720 |
| Tensile strain on net section of upper plate | 48,970 |
| Compressive strain on bearing surface of rivets | 24,990 |
| Shearing strain on rivets | 20,450 |

## No. 729.—¾″ STEEL PLATE. SET C . .

Same style of joint as No. 728.
Upper plate, 10″ × ″.739.
Under plate, 10″ × ″.735.
1⅛″ steel rivets, hand-driven.
Punched holes: Punch, 1 3/16″ diameter; die, 1 9/32″ diameter.

| | Square inches. |
|---|---|
| Gross sectional area of upper plate | 7.39 |
| Net sectional area of upper plate | 3.74 |
| Bearing surface of rivets | 7.30 |
| Shearing area of rivets | 8.86 |

| Loads applied. | Elongation in 10 inches. | Permanent set. | Remarks. |
|---|---|---|---|
| *Pounds.* | *Inch.* | *Inch.* | |
| 5,000 | 0. | | |
| 10,000 | .0005 | | |
| 20,000 | .0018 | | |
| 30,000 | .0031 | | |
| 40,000 | .0050 | | |
| 50,000 | .0080 | | |
| 55,000 | .0102 | | |
| 60,000 | .0128 | | |
| 65,000 | .0150 | | |
| 70,000 | .0168 | | |
| 75,000 | .0188 | | |
| 80,000 | .0208 | | |
| 85,000 | .0230 | | |
| 90,000 | .0250 | | |
| 95,000 | .0280 | | |
| 100,000 | .0302 | | |
| 120,000 | .04 | | |
| 140,000 | .07 | | |
| 160,000 | .09 | | |
| 177,700 | | | Ultimate strength. |

Fractured upper plate across row of rivet holes.
Fractures granular, radiating from rivet holes; four sections broke simultaneously; one end section broke last, at 170,000 pounds load; sharp snapping sound heard, the load falling slightly at the same time.

*Maximum loads on joint.*

| | Pounds per sq. inch. |
|---|---|
| Tensile strain on gross section of upper plate | 24,050 |
| Tensile strain on net section of upper plate | 47,510 |
| Compressive strain on bearing surface of rivets | 24,340 |
| Shearing strain on rivets | 20,060 |

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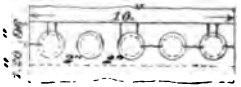
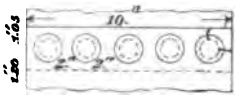
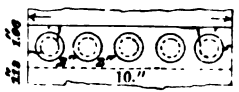
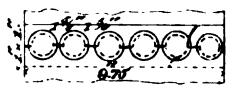
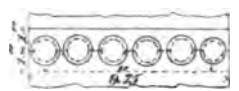
## SINGLE-RIVETED LAP JOINTS, ¼″ IRON PLATE.

| Number of test. | Distinguishing letter. | Style of joint. | Thickness of plate and kind of metal. | Size of rivets and kind of holes. | Sectional area of plate. Gross. | Sectional area of plate. Net. | Bearing surface of rivets. | Shearing area of rivets. | Tensile strength of metal. | Maximum strains on joint, pounds per square inch. Tension on gross area of plate. | Tension on net area of plate. | Compression on bearing surface of rivets. | Shearing on rivets. | Efficiency of joint. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | *Sq. in.* | *Sq. in.* | *Sq. in.* | *Sq. in.* | *Lbs. per sq. in.* | | | | | *Pr. ct.* |
| 35 | A . |  | ¼″ iron. | ⅝″ iron rivets ..... ⅝″ punched holes .. | 2.425 | 1.55 | .88 | 1.92 | 47,925 | 27,630 | **43,230** | **76,140** | **34,900** | 57.7 |
| 36 | A . . |  | ¼″ iron. | ⅝″ iron rivets ..... ⅝″ punched holes .. | 2.52 | 1.63 | .895 | 1.92 | 47,925 | 29,444 | **45,520** | 82,910 | **38,640** | 61.4 |
| 37 | C . |  | ¼″ iron. | ⅝″ iron rivets ..... ⅝″ drilled holes .... | 2.58 | 1.69 | .89 | 1.87 | 47,925 | 25,270 | **38,580** | 73,260 | **34,870** | 52.8 |
| 38 | C . . | | ¼″ iron | ⅝″ iron rivets ..... ⅝ drilled holes ..... | 2.64 | 1.73 | .911 | 1.87 | 47,925 | 27,380 | **41,790** | 79,360 | **38,660** | 57.1 |
| 39 | D . |  | ¼″ iron. | ⅝″ iron rivets ..... ⅝″ punched holes .. | 2.66 | 1.48 | 1.18 | 2.31 | 47,925 | 29,020 | **52,160** | 65,420 | 33,420 | 60.6 |
| 40 | D . . |  | ¼″ iron. | ⅝″ iron rivets ..... ⅝″ punched holes .. | 2.65 | 1.48 | 1.18 | 2.31 | 47,925 | 30,680 | **54,930** | 68,890 | 35,200 | 64.0 |

NOTE.—The figures in larger type indicate the manner of failure. When different kinds of fracture occurred in the same joint it is indicated by employing larger type in more than one column.

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SINGLE-RIVETED LAP JOINTS, ½″ IRON PLATE—Continued.

| Number of test. | Distinguishing letter. | Style of joint. | Thickness of plate and kind of metal. | Size of rivets and kind of holes. | Sectional area of plate. Gross. | Sectional area of plate. Net. | Bearing surface of rivets. | Shearing area of rivets. | Tensile strength of metal. | Maximum strains on joint, pounds per square inch. Tension on gross area of plate. | Tension on net area of plate. | Compression on bearing surface of rivets. | Shearing on rivets. | Efficiency of joint. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | *Sq. in.* | *Sq. in.* | *Sq. in.* | *Sq. in.* | *Lbs per sq. in.* | | | | | *Pr. ct.* |
| 41 | A A . | 10″ | ½″ iron. | ⅞″ steel rivets ..... | 2.41 | 1.54 | .868 | 1.92 | 47,925 | 31,580 | 49,420 | 87,670 | 39,640 | 65.9 |
| | | | | 1⅛″ punched holes ... | | | | | | | | | | |
| 42 | A A .. | 10″ | ½″ iron. | ⅞″ steel rivets ..... | 2.58 | 1.65 | .929 | 1.92 | 47,925 | 30,220 | 47,260 | 83,940 | 40,610 | 63.1 |
| | | | | 1⅛″ punched holes ... | | | | | | | | | | |
| 43 | D D . | 10″ 2½″ 2½″ 2½″ 2½″ | ½″ iron | ⅞″ steel rivets ..... | 2.40 | 1.51 | .886 | 1.53 | 47,925 | 28,875 | 45,890 | 78,220 | 45,300 | 60·3 |
| | | | | 1⅛″ punched holes ... | | | | | | | | | | |
| 44 | D D .. | 10″ 2½″ 2½″ 2½″ 2½″ | ½″ iron. | ⅞″ steel rivets ..... | 2.36 | 1.49 | .875 | 1.53 | 47,925 | 31,390 | 49,720 | 84,660 | 48,490 | 65.5 |
| | | | | 1⅛″ punched holes ... | | | | | | | | | | |
| 45 | H . | 10″ 2½″ 2½″ 2½″ 2½″ | ½″ iron. | ⅞″ iron rivets ..... | 2.73 | 1.69 | 1.04 | 1.57 | 47,925 | 25,440 | 41,095 | 66,778 | 44,294 | 53.1 |
| | | | | 1⅛″ drilled holes ..... | | | | | | | | | | |
| 46 | H .. | 10″ 2½″ 2½″ 2½″ 2½″ | ½″ iron. | ⅞″ iron rivets ..... | 2.85 | 1.76 | 1.084 | 1.57 | 47,925 | 23,158 | 37,500 | 60,886 | 42,035 | 48.3 |
| | | | | 1⅛″ drilled holes ..... | | | | | | | | | | |

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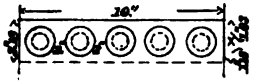
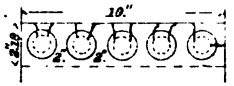
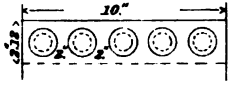
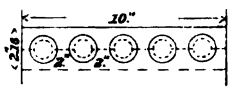
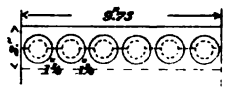
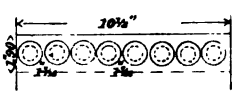
## SINGLE-RIVETED LAP JOINTS, ¼" STEEL PLATE.

| | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 426 | A. |  | ¼" steel | ⅝" iron rivets..... 1⅛" punched holes. | 2.45 | 1.57 | .882 | 1.92 | 55,765 | 29,690 | 46,340 | 82,480 | **37,890** | 53.2 |
| 427 | A.. | | ¼" steel | ⅝" iron rivets..... 1⅛" punched holes | 2.47 | 1.58 | .889 | 1.92 | 55,765 | 29,430 | 46,010 | 81,780 | **37,860** | 52.8 |
| 436 | AA. |  | ¼" steel | ⅝" steel rivets . . 1⅛" punched holes. | 2.45 | 1.57 | .882 | 1.92 | 55,765 | 38,610 | 60,250 | **107,260** | 49,270 | 69.2 |
| 437 | AA.. | | ¼" steel | ⅝" steel rivets ..... 1⅛" punched holes | 2.47 | 1.58 | .889 | 1.92 | 55,765 | 37,895 | 59,240 | **105,290** | 48,750 | 68.0 |
| 428 | C. |  | ¼" steel | ⅝" iron rivets..... 1⅛" drilled holes... | 2.53 | 1.66 | .873 | 1.87 | 55,765 | 26,870 | 40,950 | 77,870 | **36,350** | 48.2 |
| 429 | C.. | | ¼" steel | ⅝" iron rivets..... 1⅛ drilled holes... | 2.48 | 1.62 | .856 | 1.87 | 55,765 | 27,680 | 42,370 | 80,200 | **36,710** | 48.6 |
| 438 | CC. |  | ¼" steel | ⅝" steel rivets..... 1⅛" drilled holes... | 2.53 | 1.66 | .873 | 1.87 | 55,765 | 41,460 | **63,190** | 120,160 | 56,190 | 74.3 |
| 439 | CC.. | | ¼" steel | ⅝" steel rivets..... 1⅛" drilled holes... | 2.45 | 1.60 | .845 | 1.87 | 55,765 | 40,040 | **61,310** | 116,090 | 52,460 | 71.8 |
| 430 | E. |  | ¼" steel | ⅝" steel rivets..... 1⅛" drilled holes... | 2.44 | 1.40 | 1.04 | 2.24 | 55,765 | 38,360 | **66,860** | 90,000 | 41,790 | 68.8 |
| 431 | E.. | | ¼" steel | ⅝" steel rivets ..... 1⅛" drilled holes... | 2.44 | 1.40 | 1.04 | 2.24 | 55,765 | 40,160 | **70,000** | 94,230 | 43,750 | 72.0 |
| 47 | H. |  | ¼" steel | ⅞" steel rivets.... 1" drilled holes.... | 2.66 | 1.64 | 1.012 | 1.57 | 55,765 | 38,496 | 62,496 | 101,180 | **65,220** | 69.0 |

NOTE.—The figures in larger type indicate the manner of failure. When different kinds of fracture occurred in the same joint it is indicated by employing larger type in more than one column.

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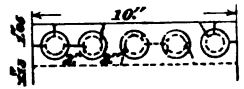
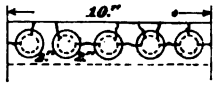
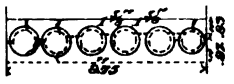
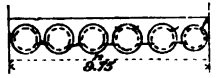
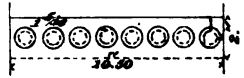
SINGLE-RIVETED LAP JOINTS, ¼″ IRON PLATE—Continued.

| Number of test. | Distinguishing letter. | Style of joint. | Thickness of plate and kind of metal. | Size of rivets and kind of holes. | Sectional area of plate. | | Bearing surface of rivets. | Shearing area of rivets. | Tensile strength of metal. | Maximum strains on joint, pounds per square inch. | | | | Efficiency of joint. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Gross. | Net. | | | | Tension on gross area of plate. | Tension on net area of plate. | Compression on bearing surface of rivets. | Shearing on rivets. | |
| | | | | | *Sq. in.* | *Sq. in.* | *Sq. in.* | *Sq. in.* | *Lbs per sq. in.* | | | | | *Pr. ct.* |
| 41 | A A. |  | ¼″ iron. | ⅝″ steel rivets..... 1⅛″ punched holes... | 2.41 | 1.54 | .868 | 1.92 | 47,925 | 31,580 | **49,420** | **87,670** | 39,640 | 65.9 |
| 42 | A A.. |  | ¼″ iron. | ⅝″ steel rivets..... 1⅛″ punched holes.. | 2.58 | 1.65 | .929 | 1.92 | 47,925 | 30,220 | **47,260** | **83,940** | 40,610 | 63.1 |
| 43 | D D. |  | ¼″ iron | ⅝″ steel rivets..... ⅞″ punched holes.. | 2.40 | 1.51 | .886 | 1.53 | 47,925 | 28,875 | **45,890** | **78,220** | 45,300 | 60·3 |
| 44 | D D.. |  | ¼″ iron. | ⅝″ steel rivets..... ⅞″ punched holes.. | 2.36 | 1.49 | .875 | 1.53 | 47,925 | 31,390 | **49,720** | **84,660** | 48,490 | 65.5 |
| 45 | H. | | ¼″ iron. | ⅞″ iron rivets ..... ⅝″ drilled holes ..... | 2.73 | 1.69 | 1.04 | 1.57 | 47,925 | 25,440 | 41,095 | 66,778 | **44,204** | 53.1 |
| 46 | H.. |  | ¼″ iron. | ⅞″ iron rivets ..... ⅝″ drilled holes ..... | 2.85 | 1.76 | 1.084 | 1.57 | 47,925 | 23,158 | **37,500** | 60,886 | **42,038** | 48.3 |

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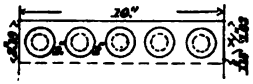
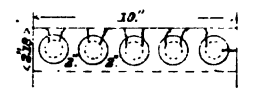
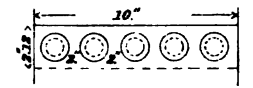
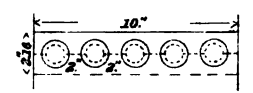
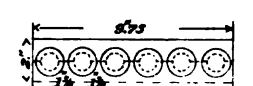
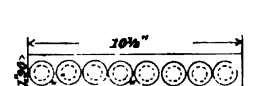
## SINGLE-RIVETED LAP JOINTS, ¼″ STEEL PLATE.

| | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 426 | A. |  | ¼″ steel | ⅝″ iron rivets..... ⅛″ punched holes. | 2.45 | 1.57 | .882 | 1.92 | 55,765 | 29,690 | 46,340 | 82,480 | **37,890** | 53.2 |
| 427 | A.. | | ¼″ steel | ⅝″ iron rivets..... ⅛″ punched holes | 2.47 | 1.58 | .889 | 1.92 | 55,765 | 29,430 | 46,010 | 81,780 | **37,860** | 52.8 |
| 436 | AA. |  | ¼″ steel | ⅝″ steel rivets ... ⅛″ punched holes. | 2.45 | 1.57 | .882 | 1.92 | 55,765 | 38,610 | 60,250 | **107,260** | 49,270 | 69.2 |
| 437 | AA.. | | ¼″ steel | ⅝″ steel rivets..... ⅛″ punched holes | 2.47 | 1.58 | .889 | 1.92 | 55,765 | 37,895 | 59,240 | **105,290** | 48,750 | 68.0 |
| 428 | C. |  | ¼″ steel | ⅝″ iron rivets..... ⅛″ drilled holes... | 2.53 | 1.66 | .873 | 1.87 | 55,765 | 26,870 | 40,950 | 77,870 | **36,350** | 48.2 |
| 429 | C.. | | ¼″ steel | ⅝″ iron rivets..... ⅛″ drilled holes... | 2.48 | 1.62 | .856 | 1.87 | 55,765 | 27,680 | 42,370 | 80,200 | **36,710** | 49.6 |
| 438 | CC. |  | ¼″ steel | ⅝″ steel rivets..... ⅛″ drilled holes... | 2.53 | 1.66 | .873 | 1.87 | 55,765 | 41,460 | **63,190** | 120,160 | 56,190 | 74.3 |
| 439 | CC.. | | ¼″ steel | ⅝″ steel rivets..... ⅛″ drilled holes... | 2.45 | 1.60 | .845 | 1.87 | 55,765 | 40,040 | **61,310** | 116,090 | 52,460 | 71.8 |
| 430 | E. |  | ¼″ steel | ⅝″ steel rivets..... ⅛″ drilled holes... | 2.44 | 1.40 | 1.04 | 2.24 | 55,765 | 38,360 | **66,860** | 90,000 | 41,790 | 68.8 |
| 431 | E.. | | ¼″ steel | ⅝″ steel rivets..... ⅛″ drilled holes... | 2.44 | 1.40 | 1.04 | 2.24 | 55,765 | 40,160 | **70,000** | 94,230 | 43,750 | 72.0 |
| 47 | H. |  | ¼″ steel | 7/16″ steel rivets.... ⅜″ drilled holes.... | 2.66 | 1.64 | 1.012 | 1.57 | 55,765 | 38,496 | 62,496 | 101,180 | **65,220** | 69.0 |

NOTE.—The figures in larger type indicate the manner of failure. When different kinds of fracture occurred in the same joint it is indicated by employing larger type in more than one column.

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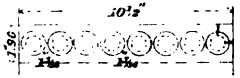
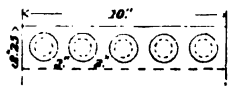
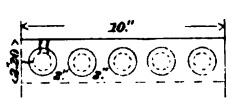
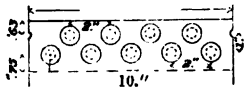
SINGLE-RIVETED LAP JOINTS, ¼″ IRON PLATE—Continued.

| Number of test. | Distinguishing letter. | Style of joint. | Thickness of plate and kind of metal. | Size of rivets and kind of holes. | Sectional area of plate. Gross. | Sectional area of plate. Net. | Bearing surface of rivets. | Shearing area of rivets. | Tensile strength of metal. | Maximum strains on joint, pounds per square inch. Tension on gross area of plate. | Tension on net area of plate. | Compression on bearing surface of rivets. | Shearing on rivets. | Efficiency of joint. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | *Sq.in.* | *Sq.in.* | *Sq.in.* | *Sq.in.* | *Lbs. per sq. in.* | | | | | *Pr. ct.* |
| 48 | H . . |   | ¼″ steel | ⅞″ steel rivets ⅞″ drilled holes | 2.625 | 1.623 | 1.00 | 1.57 | 55,765 | 36,114 | 58,338 | 94,800 | **60,382** | 64.8 |
| 49 | CCC. |   | ¼″ steel | ⅞ steel rivets 15/16″ drilled holes | 2.49 | 1.63 | .856 | 1.86 | 55,765 | 39,400 | 60,184 | 114,603 | **52,742** | 70.6 |
| 50 | CCC.. |   | ¼″ steel | ⅞″ steel rivets 15/16″ drilled holes | 2.50 | 1.64 | .859 | 1.86 | 55,765 | 39,680 | 57,439 | 109,650 | **50,645** | 67.8 |

DOUBLE-RIVETED LAP JOINTS, ¼″ IRON AND STEEL PLATE.

| | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 85 | I. |   | ¼″ iron. | ⅞″ iron rivets ⅞″ drilled holes | 2.64 | 1.98 | 1.19 | 1.77 | 47,925 | 28,900 | 38,535 | 64,120 | **43,110** | 60.3 |

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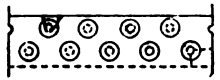
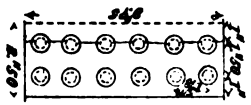
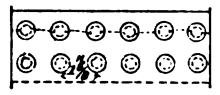
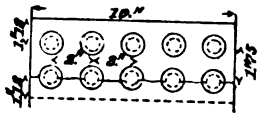
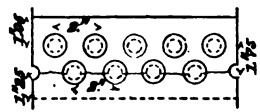
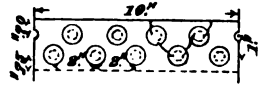
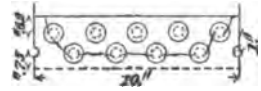
| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 86 | I . . |  | ⅜″ iron. | ⅞″ iron rivets ..... ⅞″ drilled holes ..... | 2.36 | 1.77 | 1.06 | 1.77 | 47,925 | 31,814 | **41,750** | **69,710** | **41,750** | 65.3 |
| 617 | K . |  | ⅜″ iron. | ⅞″ iron rivets ..... ⅞″ punched holes .. | 2.71 | 1.69 | 2.03 | 2.98 | 47,925 | 31,550 | **50,592** | 42,118 | 28,691 | 65.8 |
| 618 | K . . |  | ⅜″ iron | ⅞″ iron rivets ..... ⅞″ punched holes .. | 2.73 | 1.71 | 2.05 | 2.98 | 47,925 | 31,282 | **49,950** | 41,660 | 28,660 | 65.3 |
| 432 | F . |  | ⅜″ steel | ⅞″ iron rivets ..... ⅞″ punched holes .. | 2.49 | 1.59 | 1.79 | 3.85 | 55,765 | 39,280 | **61,510** | 54,640 | 25,400 | 70.4 |
| 433 | F . . | | ⅜″ steel | ⅞″ iron rivets ..... ⅞″ punched holes .. | 2.54 | 1.63 | 1.83 | 3.85 | 55,765 | 38,700 | **60,300** | 53,715 | 25,530 | 69.4 |
| 434 | G . |  | ⅜″ steel | ⅞″ iron rivets ..... ⅞″ punched holes .. | 2.52 | 1.61 | 1.63 | 3.46 | 55,765 | 41,785 | **65,400** | 64,600 | 30,430 | 74.9 |
| 435 | G . . | | ⅜″ steel | ⅞″ iron rivets ..... ⅞″ punched holes .. | 2.54 | 1.63 | 1.66 | 3.46 | 55,765 | 41,460 | **64,600** | 63,430 | 30,430 | 74.3 |
| 87 | I . |  | ⅜″ steel | ⅞″ steel rivets..... ⅞″ drilled holes ..... | 2.41 | 1.80 | 1.08 | 1.77 | 55,765 | 42,530 | 56,944 | **94,910** | **57,910** | 76.3 |
| 88 | I . . |  | ⅜″ steel | ⅞″ steel rivets..... ⅞″ drilled holes ..... | 2.44 | 1.83 | 1.10 | 1.77 | 55,765 | 44,344 | **59,130** | 98,360 | 61,130 | 79.5 |

NOTE.—The figures in larger type indicate the manner of failure. When different kinds of fracture occurred in the same joint, it is indicated by employing larger type in more than one column.

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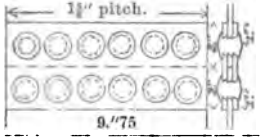
DOUBLE-WELT BUTT JOINTS ¼″ IRON PLATE.

| Number of test. | Distinguishing letter. | Style of joint. | Size of rivets and kind of holes. | Sectional area of plate. Gross. | Sectional area of plate. Net. | Bearing surface of rivets. | Shearing area of rivets. | Tensile strength of metal. | Maximum strains on joint, pounds per square inch.* Tension on gross area of plate. | Tension on net area of plate. | Compression on bearing surface of rivets. | Shearing on rivets. | Efficiency of joint. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | *Sq. inch.* | *Sq. inch.* | *Sq. inch.* | *Sq. inch.* | *Lbs. per sq. inch.* | | | | | *Pr. ct.* |
| 615 | L. |   | ⅞″ iron rivets. 1 1/16″ punched holes | 2.53 | 1.41 | 1.12 | 4.45 | 47,925 | 29,800 | **53,475** | 67,321 | 16,944 | 62.2 |
| 616 | L.. | | .....do.....do | 2.62 | 1.46 | 1.16 | 4.45 | 47,925 | 28,397 | **50,959** | 64,138 | 16,719 | 59.3 |

NOTE.—The figures in larger type indicate the manner of failure. When different kinds of fracture occurred in the same joint, it is indicated by employing larger type in more than one column.

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## SINGLE-RIVETED LAP JOINTS, ⅜″ IRON PLATE.

| Number of test. | Distinguishing letter. | Style of joint. | Thickness of plate and kind of metal. | Size of rivets and kind of holes. | Sectional area of plate. Gross. | Sectional area of plate. Net. | Bearing surface of rivets. | Shearing area of rivets. | Tensile strength of metal. | Maximum strains on joint, pounds per square inch.* Tension on gross area of plate. | Tension on net area of plate. | Compression on bearing surface of rivets. | Shearing on rivets. | Efficiency of joint. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | *Sq.in.* | *Sq.in.* | *Sq.in.* | *Sq.in.* | *Lbs.per sq. in.* | | | | | *Pr. ct.* |
| 62 | A. | 10.″ | ⅜″ iron. | ⅞″ iron rivets ..... ¾″ punched holes ... | 3.76 | 2.32 | 1.44 | 2.27 | 47,180 | 23 110 | 37, 460 | **60,340** | **38,280** | 49.0 |
| 63 | A.. | 10.″ | ⅜″ iron. | ⅞″ iron rivets ..... ¾″ punched holes ... | 3.81 | 2.35 | 1.46 | 2.30 | 47,180 | 22, 280 | **36,130** | **58,150** | 35, 520 | 47.2 |
| 64 | C. | 10.″ | ⅜″ iron. | ⅞″ iron rivets ..... ¾″ drilled holes ..... | 3.73 | 2.29 | 1.44 | 2.33 | 47,180 | 23, 445 | 38, 190 | 60, 730 | **37,530** | 49.7 |
| 65 | C.. | 10.″ | ⅜″ iron | ⅞″ iron rivets ..... ¾″ drilled holes ..... | 3.78 | 2.32 | 1.46 | 2.33 | 47,180 | 22, 220 | 36, 210 | 57 530 | **36,050** | 47.1 |
| 66 | D. | 10⅜″ | ⅜″ iron. | ⅞″ iron rivets ..... ¾″ punched holes .. | 3.95 | 2.23 | 1.72 | 2.72 | 47, 180 | 23, 570 | **41,750** | 54, 130 | 34, 230 | 50.0 |
| 67 | D.. | 10⅜″ | ⅜″ iron. | ⅞″ iron rivets ..... ¾″ punched holes ... | 3.99 | 2.25 | 1.74 | 2.72 | 47, 180 | 23, 280 | **41,290** | 53, 400 | 34, 150 | 49.3 |
| 720 | K. | 2 1/16″ pitch. | ⅜″ iron. | 1″ iron rivets ..... 1 1/16″ punched holes.. | 4.07 | 1.88 | 2.19 | 4.43 | 47, 180 | 28, 500 | **61.700** | 52, 970 | 26, 180 | 60.4 |
| 721 | K.. | 10.″33 | ⅜″ iron. | 1″ iron rivets ..... 1 1/16″ punched holes . | 4.08 | 1.88 | 2.19 | 4.43 | 47, 180 | 26, 960 | **58,510** | 50, 229 | 24, 830 | 57.1 |

NOTE.—The figures in larger type indicate the manner of failure. When different kinds of fracture occurred in the same joint, it is indicated by employing larger type in more than one column.

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SINGLE-RIVETED LAP JOINTS, ⅜″ STEEL PLATE.

| Number of test. | Distinguishing letter. | Style of joint. | Thickness of plate and kind of metal. | Size of rivets and kind of holes. | Sectional area of plate. Gross. | Sectional area of plate. Net. | Bearing surface of rivets. | Shearing area of rivets. | Tensile strength of metal. | Maximum strains on joint, pounds per square inch. Tension on gross area of plate. | Tension on net area of plate. | Compression on bearing surface of rivets. | Shearing on rivets. | Efficiency of joint. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | *Sq.in.* | *Sq.in.* | *Sq in.* | *Sq.in.* | *Lbs. per sq. in.* | | | | | *Pr. ct.* |
| 51 | A. | | ⅜″ steel | ⅞″ iron rivets ⅝″ punched holes | 3.73 | 2.30 | 1.427 | 2.27 | 53,330 | 24,180 | 39,220 | 63,210 | **39,740** | 45.4 |
| 52 | A.. | | ⅜″ steel | ⅞″ iron rivets ⅝″ punched holes | 3.73 | 2.30 | 1.427 | 2.27 | 53,330 | 23,240 | 37,700 | 60,760 | **38,190** | 43.6 |
| 53 | AA. | | ⅜″ steel | ⅞″ steel rivets ⅝″ punched holes | 3.75 | 2.32 | 1.43 | 2.27 | 53,330 | 34,160 | 55,215 | **89,580** | **56,430** | 64.1 |
| 54 | AA.. | | ⅜″ steel | ⅞″ steel rivets ⅝″ punched holes | 3.72 | 2.30 | 1.42 | 2.27 | 53,330 | 33,840 | 54,740 | **88,660** | **55,460** | 63.5 |
| 55 | E. | | ⅜″ steel | ⅞″ steel rivets ⅝″ drilled holes | 3.97 | 2.22 | 1.746 | 2.79 | 53,330 | 35,590 | **63,650** | 80,930 | **50,650** | 66.7 |
| 56 | E.. | | ⅜″ steel | ⅞″ steel rivets ⅝″ drilled holes | 3.96 | 2.22 | 1.74 | 2.79 | 53,330 | 35,860 | **63,976** | 81,600 | **50,900** | 67.2 |
| 238 | CC. | | ⅜″ steel | ¾″ steel rivets ⅞″ punched holes | 3.74 | 2.16 | 1.58 | 2.64 | 53,330 | 37,810 | 65,460 | **89,490** | **53,560** | 70.9 |

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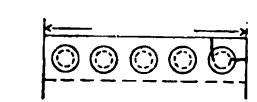
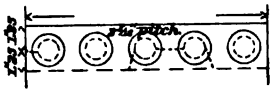
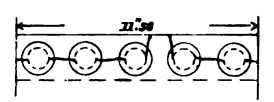
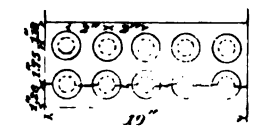
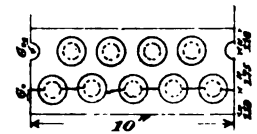
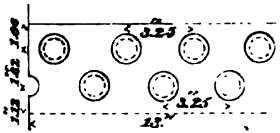
| | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 239 | C C . . |  | ⅜″ steel | ⅞″ steel rivets ..... ⅛″ punched holes .. | 3.76 | 2.17 | 1.59 | 2.64 | 53,330 | 37,630 | 65,210 | **88,990** | **53,600** | 70.6 |
| 718 | K . |  | ⅜″ steel | 1″ iron rivets ..... 1⅛″ punched holes | 4.26 | 2.21 | 2.04 | 4.43 | 53,330 | 38,075 | **73,394** | **79,510** | **36,614** | 71.4 |
| 719 | K . . |  | ⅜″ steel | 1″ iron rivets ..... 1⅛″ punched holes | 4.22 | 2.19 | 2 02 | 4.43 | 53,330 | 38,390 | **73,970** | **80,200** | 36,590 | 72.0 |

DOUBLE-RIVETED LAP JOINTS, ⅜″ IRON AND STEEL PLATE.

| | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 68 | F . |  | ⅜″ iron | ⅞″ iron rivets ..... ¾″ punched holes ... | 3.75 | 2.32 | 2.87 | 4.54 | 47,180 | 29,970 | **48,450** | 39,160 | 24,760 | 63.5 |
| 69 | F . . | | ⅜″ iron | ⅞″ iron rivets ..... ¾″ punched holes.... | 3.79 | 2.34 | 2.89 | 4.54 | 47,180 | 31,320 | **50,730** | 41,070 | 26,150 | 66.4 |
| 58 | F . . . | | ⅜″ iron. | ⅞″ iron rivets ..... ¾″ punched holes ... | 3.71 | 2.29 | 2.83 | 4.54 | 47,180 | 31,000 | **50,220** | 40,640 | 25,330 | 65.7 |
| 70 | G . |  | ⅜″ iron | ⅞″ iron rivets ..... ¾″ punched holes.... | 3.94 | 2.43 | 2.71 | 4.08 | 47,180 | 28,530 | **46,255** | 41,480 | 27,550 | 60.5 |
| 71 | G . . | | ⅜″ iron. | ⅞″ iron rivets ..... ¾″ punched holes ... | 3.87 | 2.39 | 2.67 | 4.08 | 47,180 | 28,475 | **46,110** | 41,270 | 27,010 | 60.4 |
| 81 | I . |  | ⅜″ iron. | 1⅛″ iron rivets ..... ¾″ drilled holes .... | 5.09 | 3.91 | 2.06 | 3.08 | 47,180 | 23,750 | 30,920 | 58,700 | **39,130** | 50.4 |
| 82 | I . . | | ⅜″ iron | 1⅛″ iron rivets ..... ¾″ drilled holes..... | 5.12 | 3 94 | 2.07 | 3.09 | 47,180 | 23,180 | 30,130 | 57,340 | **38,410** | 49.1 |

NOTE.—The figures in larger type indicate the manner of failure. When different kinds of fracture occurred in the same joint, it is indicated by employing larger type in ore than one column.

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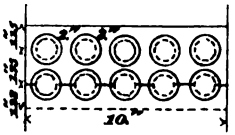
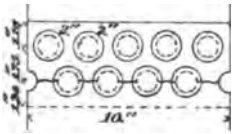
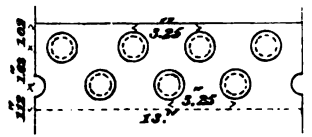
DOUBLE-RIVETED LAP JOINTS, ⅜″ IRON AND STEEL PLATE—Continued.

| Number of tests. | Distinguishing letter. | Style of joint. | Thickness of plate and kind of metal. | Size of rivets and kind of holes. | Sectional area of plate. Gross. | Sectional area of plate. Net. | Bearing surface of rivets. | Shearing area of rivets. | Tensile strength of metal. | Maximum strains on joint, pounds per square inch. Tension on gross area of plate. | Tension on net area of plate. | Compression on bearing surface of rivets. | Shearing on rivets. | Efficiency of joint. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | *Sq. in.* | *Sq. in.* | *Sq. in.* | *Sq. in.* | *Lbs. per sq. in.* | | | | | *Pr. ct.* |
| 57 | F. |  | ⅜″ steel. | 1⅛″ iron rivets ..... ⅞″ punched holes ... | 3.76 | 2.32 | 2.89 | 4.54 | 53,330 | 39,020 | **62,800** | 50,760 | 32,310 | 73.2 |
| 59 | F.. | | ⅜″ steel. | 1⅛″ iron rivets ..... ⅞″ punched holes.... | 3.73 | 2.31 | 2.85 | 4.54 | 53,330 | 40,080 | **64,720** | 52,450 | 32,930 | 75.2 |
| 60 | G. |  | ⅜″ steel. | 1⅛″ iron rivets ..... ⅞″ punched holes.... | 3.63 | 2.24 | 2.49 | 4.08 | 53,330 | 39,010 | **63,210** | 56,860 | 34,710 | 73.2 |
| 61 | G.. | | ⅜″ steel. | 1⅛″ iron rivets ..... ⅞″ punched holes ... | 3.70 | 2.29 | 2.54 | 4.08 | 53,330 | 34,000 | **54,930** | 49,530 | 30,830 | 63.8 |
| 83 | I. |  | ⅜″ steel. | 1⅛″ steel rivets ..... ⅞″ drilled holes .... | 4.75 | 3.65 | 1.93 | 3.09 | 53,330 | 34,316 | 44,660 | 84,460 | **52,750** | 64.4 |
| 84 | I.. | | ⅜″ steel. | 1⅛″ steel rivets..... ⅞″ drilled holes..... | 4.77 | 3.67 | 1.93 | 3.09 | 53,330 | 33,585 | 43,650 | 83,000 | **51,845** | 63.0 |

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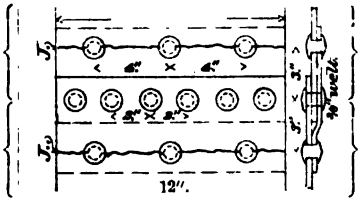
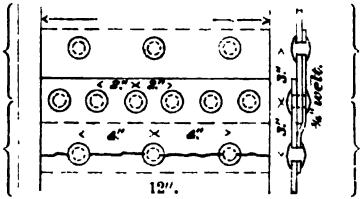
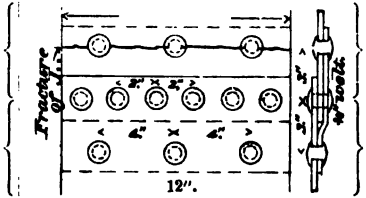
## RIVETED JOINTS, ⅜″ IRON AND STEEL PLATE REINFORCED LAP JOINTS.

| | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 244 | J. |  | ⅜″ iron. | ⅞″ iron rivets ..... ″.72 drilled holes .... | 4.63 | 3.80 | 2.50 | 3.66 | 47,180 | 31,900 | **38,870** | 59,080 | **40,360** | 67.6 |
| 245 | J.. | | ⅜″ iron. | ⅞″ iron rivets ..... 1⅛″ drilled holes .... | 4.69 | 3.74 | 2.89 | 4.75 | 47,180 | 34,900 | **43,770** | 56,640 | 34,460 | 74.0 |
| 296 | JJ. |  | ⅜″ iron. | ⅞″ iron rivets ..... 1⅛″ drilled holes .... | 4.51 | 3.59 | 2.78 | 4.75 | 47,180 | 35,700 | **44,840** | 57,910 | 33,890 | 75.7 |
| 297 | JJ.. | | ⅜″ iron. | ⅞″ iron rivets ..... 1⅛″ drilled holes ... | 4.45 | 3.54 | 2.73 | 4.75 | 47,180 | 33,950 | **42,680** | 55,350 | 31,810 | 71.9 |
| 246 | J. |  | ⅜″ steel | ⅞″ steel rivets..... 1⅛″ drilled holes ... | 4.34 | 3.32 | 3.06 | 6.25 | 53,330 | 47,465 | **62,050** | 67,320 | 32,960 | 89.0 |
| 247 | J.. | | ⅜″ steel | ⅞″ steel rivets ..... 1⅛″ drilled holes ... | 4.41 | 3.37 | 3.11 | 6.25 | 53,330 | 48,050 | **62,880** | 68,135 | 33,900 | 90.1 |

NOTE.—The figures in larger type indicate the manner of failure. When different kinds of fracture occurred in the same joint, it is indicated by employing larger type in more than one column.

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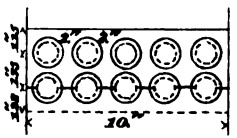
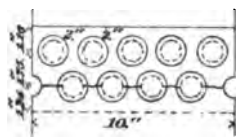
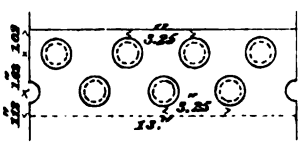
DOUBLE-RIVETED LAP JOINTS, ⅜″ IRON AND STEEL PLATE—Continued.

| Number of tests. | Distinguishing letter. | Style of joint. | Thickness of plate and kind of metal. | Size of rivets and kind of holes. | Sectional area of plate. Gross. | Sectional area of plate. Net. | Bearing surface of rivets. | Shearing area of rivets. | Tensile strength of metal. | Maximum strains on joint, pounds per square inch. Tension on gross area of plate. | Tension on net area of plate. | Compression on bearing surface of rivets. | Shearing on rivets. | Efficiency of joint. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | *Sq. in.* | *Sq. in.* | *Sq. in.* | *Sq. in.* | *Lbs. per sq. in.* | | | | | *Pr. ct.* |
| 57 | F. |  | ⅜″ steel. | 1⅛″ iron rivets ..... ⅝″ punched holes ... | 3.76 | 2.32 | 2.89 | 4.54 | 53,330 | 39,020 | **62,800** | 50,760 | 32,310 | 73.2 |
| 59 | F.. | | ⅜″ steel. | 1⅛″ iron rivets ..... ⅝″ punched holes .... | 3.73 | 2.31 | 2.85 | 4.54 | 53,330 | 40,080 | **64,720** | 52,450 | 32,930 | 75.2 |
| 60 | G. |  | ⅜″ steel. | 1⅛″ iron rivets ..... ⅝″ punched holes .... | 3.63 | 2.24 | 2.49 | 4.08 | 53,330 | 39,010 | **63,210** | 56,860 | 34,710 | 73.2 |
| 61 | G.. | | ⅜″ steel. | 1⅛″ iron rivets ..... ⅝″ punched holes ... | 3.70 | 2.29 | 2.54 | 4.08 | 53,330 | 34,000 | **54,930** | 49,530 | 30,830 | 63.8 |
| 83 | I. |  | ⅜″ steel. | 1⅛″ steel rivets ..... ⅝″ drilled holes .... | 4.75 | 3.65 | 1.93 | 3.09 | 53,330 | 34,316 | 44,660 | 84,460 | **52,750** | 64.4 |
| 84 | I.. | | ⅜″ steel. | 1⅛″ steel rivets..... ⅝″ drilled holes..... | 4.77 | 3.67 | 1.93 | 3.09 | 53,330 | 33,585 | 43,650 | 83,000 | **51,845** | 63.0 |

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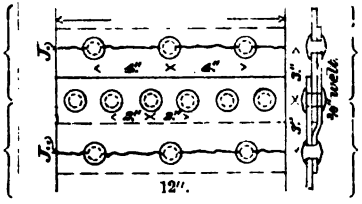
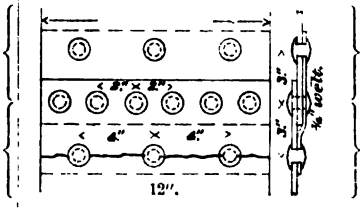
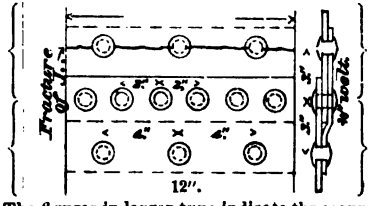
## RIVETED JOINTS, ⅜″ IRON AND STEEL PLATE REINFORCED LAP JOINTS.

| | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 244 | J. |  | ⅜″ iron. | ⅝″ iron rivets ..... .72 drilled holes .... | 4.63 | 3.80 | 2.50 | 3.66 | 47,180 | 31,900 | 38,870 | 59,080 | **40,360** | 67.6 |
| 245 | J. . | | ⅜″ iron. | ¾″ iron rivets ..... ⅞″ drilled holes .... | 4.69 | 3.74 | 2.89 | 4.75 | 47,180 | 34,900 | **43,770** | 56,640 | 34,460 | 74.0 |
| 296 | J J. |  | ⅜″ iron. | ¾″ iron rivets ..... ⅞″ drilled holes .... | 4.51 | 3.59 | 2.78 | 4.75 | 47,180 | 35,700 | **44,840** | 57,910 | 33,890 | 75.7 |
| 297 | J J. . | | ⅜″ iron. | ¾″ iron rivets ..... ⅞″ drilled holes ... | 4.45 | 3.54 | 2.73 | 4.75 | 47,180 | 33,950 | **42,680** | 55,350 | 31,810 | 71.9 |
| 246 | J. |  | ⅜″ steel | ⅝″ steel rivets..... ⅞″ drilled holes ... | 4.34 | 3.32 | 3.06 | 6.25 | 53,330 | 47,465 | **62,050** | 67,320 | 32,960 | 89.0 |
| 247 | J. . | | ⅜″ steel | ⅝″ steel rivets ..... ⅞″ drilled holes ... | 4.41 | 3.37 | 3.11 | 6.25 | 53,330 | 48,050 | **62,880** | 68,135 | 33,900 | 90.1 |

NOTE.—The figures in larger type indicate the manner of failure. When different kinds of fracture occurred in the same joint, it is indicated by employing larger type in more than one column.

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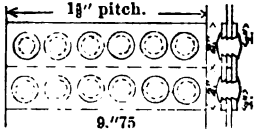
## DOUBLE-WELT BUTT JOINTS ¼″ IRON PLATE.

| Number of test. | Distinguishing letter. | Style of joint. | Size of rivets and kind of holes. | Sectional area of plate. | | Bearing surface of rivets. | Shearing area of rivets. | Tensile strength of metal. | Maximum strains on joint, pounds per square inch.* | | | | Efficiency of joint. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Gross. | Net. | | | | Tension on gross area of plate. | Tension on net area of plate. | Compression on bearing surface of rivets. | Shearing on rivets. | |
| | | | | *Sq. inch.* | *Sq. inch.* | *Sq. inch.* | *Sq. inch.* | *Lbs. per sq. inch.* | | | | | *Pr. ct.* |
| 615 | L. |   | ⅝″ iron rivets. 11/16″ punched holes | 2.53 | 1.41 | 1.12 | 4.45 | 47,925 | 29,800 | **53,475** | 67,321 | 16,944 | 62.2 |
| 616 | L.. | | .....do.....do | 2.62 | 1.46 | 1.16 | 4.45 | 47,925 | 28,397 | **50,959** | 64,138 | 16,719 | 59.3 |

NOTE.—The figures in larger type indicate the manner of failure. When different kinds of fracture occurred in the same joint, it is indicated by employing larger type in more than one column.

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## SINGLE-RIVETED LAP JOINTS, ⅜″ IRON PLATE.

| Number of test. | Distinguishing letter. | Style of joint. | Thickness of plate and kind of metal. | Size of rivets and kind of holes. | Sectional area of plate. Gross. | Sectional area of plate. Net. | Bearing surface of rivets. | Shearing area of rivets. | Tensile strength of metal. | Maximum strains on joint, pounds per square inch.* Tension on gross area of plate. | Tension on net area of plate. | Compression on bearing surface of rivets. | Shearing on rivets. | Efficiency of joint. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | *Sq.in.* | *Sq.in.* | *Sq.in.* | *Sq.in.* | *Lbs.per. sq. in.* | | | | | *Pr. ct.* |
| 62 | A. | 10.″ | ⅜″ iron. | ⅞″ iron rivets ..... ¾″ punched holes ... | 3.76 | 2.32 | 1.44 | 2.27 | 47,180 | 23 110 | 37,460 | **60,340** | **38,280** | 49.0 |
| 63 | A.. | 10.″ | ⅜″ iron. | ⅞″ iron rivets ..... ¾″ punched holes ... | 3.81 | 2.35 | 1.46 | 2.39 | 47,180 | 22,280 | **36,130** | **58,150** | 35,520 | 47.2 |
| 64 | C. | 10.″ | ⅜″ iron. | ⅞″ iron rivets ..... ¾″ drilled holes .... | 3.73 | 2.29 | 1.44 | 2.33 | 47,180 | 23,445 | 38,190 | 60,730 | **37,530** | 49.7 |
| 65 | C.. | 10.″ | ⅜″ iron | ⅞″ iron rivets ..... ¾″ drilled holes ..... | 3.78 | 2.32 | 1.46 | 2.33 | 47,180 | 22,220 | 36,210 | 57 530 | **36,050** | 47.1 |
| 66 | D. | 10⅜″ | ⅜″ iron. | ⅞″ iron rivets ..... ¾″ punched holes ... | 3.95 | 2.23 | 1.72 | 2.72 | 47,180 | 23,570 | **41,750** | 54,130 | 34,230 | 50.0 |
| 67 | D.. | 10⅜″ | ⅜″ iron. | ⅞″ iron rivets ..... ¾″ punched holes .... | 3.99 | 2.25 | 1.74 | 2.72 | 47,180 | 23,280 | **41,290** | 53,400 | 34,150 | 49.3 |
| 720 | K. | 2 1/16″ pitch. | ⅜″ iron. | 1″ iron rivets ..... 1 1/16″ punched holes.. | 4.07 | 1.88 | 2.19 | 4.43 | 47,180 | 28,500 | **61,700** | 52,970 | 26,180 | 60.4 |
| 721 | K.. | 10.″33 | ⅜″ iron. | 1″ iron rivets ..... 1 1/16″ punched holes . | 4.08 | 1.88 | 2.19 | 4.43 | 47,180 | 26,960 | **58,510** | 50,229 | 24,830 | 57.1 |

NOTE.—The figures in larger type indicate the manner of failure. When different kinds of fracture occurred in the same joint, it is indicated by employing larger type in more than one column.

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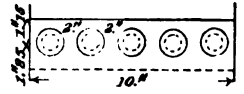
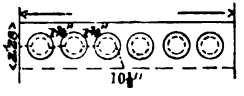
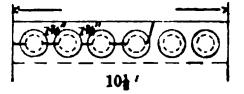
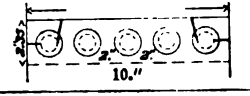
SINGLE-RIVETED LAP JOINTS, ⅜″ STEEL PLATE.

| Number of test. | Distinguishing letter. | Style of joint. | Thickness of plate and kind of metal. | Size of rivets and kind of holes. | Sectional area of plate. Gross. | Net | Bearing surface of rivets. | Shearing area of rivets. | Tensile strength of metal. | Maximum strains on joint, pounds per square inch. Tension on gross area of plate. | Tension on net area of plate. | Compression on bearing surface of rivets. | Shearing on rivets. | Efficiency of joint. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | *Sq.in.* | *Sq.in.* | *Sq.in.* | *Sq.in.* | *Lbs. per sq. in.* | | | | | *Pr. ct.* |
| 51 | A. |  | ⅜″ steel | ⅞″ iron rivets ⅝″ punched holes | 3.73 | 2.30 | 1.427 | 2.27 | 53,330 | 24,180 | 39,220 | 63,210 | **39,740** | 45.4 |
| 52 | A.. | | ⅜″ steel | ⅞″ iron rivets ⅝″ punched holes | 3.73 | 2.30 | 1.427 | 2.27 | 53,330 | 23,240 | 37,700 | 60,760 | **38,190** | 43.6 |
| 53 | AA. | | ⅜″ steel | ⅞″ steel rivets ⅝″ punched holes | 3.75 | 2.32 | 1.43 | 2.27 | 53,330 | 34,160 | 55,215 | **89,580** | **56,430** | 64.1 |
| 54 | AA.. | | ⅜″ steel | ⅞″ steel rivets ⅝″ punched holes | 3.72 | 2.30 | 1.42 | 2.27 | 53,330 | 33,840 | 54,740 | **88,660** | **55,460** | 63.5 |
| 55 | E. |  | ⅜″ steel | ⅞″ steel rivets ⅝″ drilled holes | 3.97 | 2.22 | 1.746 | 2.79 | 53,330 | 35,590 | **63,650** | 80,930 | **50,650** | 66.7 |
| 56 | E.. |  | ⅜″ steel | ⅞″ steel rivets ⅝″ drilled holes | 3.96 | 2.22 | 1.74 | 2.79 | 53,330 | 35,860 | **63,976** | 81,600 | **50,900** | 67.2 |
| 238 | CC. |  | ⅜″ steel | ¾″ steel rivets ⅞″ punched holes | 3.74 | 2.16 | 1.58 | 2.64 | 53,330 | 37,810 | 65,460 | **89,490** | **53,560** | 70.9 |

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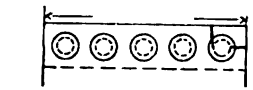
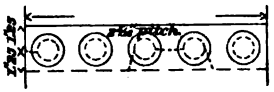
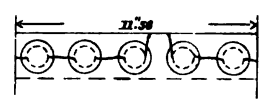
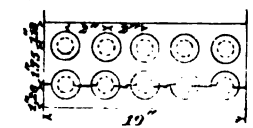
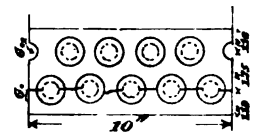
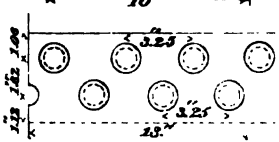
| | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 239 | C C . . |  | ⅜″ steel | ⅞″ steel rivets ..... ⅞″ punched holes .. | 8.76 | 2.17 | 1.59 | 2.64 | 53,330 | 37,630 | 65,210 | **88,990** | **53,600** | 70.6 |
| 718 | K . |  | ⅜″ steel | 1″ iron rivets ..... 1⅛″ punched holes | 4.26 | 2.21 | 2.04 | 4.43 | 53,330 | 38,075 | **73,394** | **79,510** | **36,614** | 71.4 |
| 719 | K . . |  | ⅜″ steel | 1″ iron rivets ..... 1⅛″ punched holes | 4.22 | 2.19 | 2 02 | 4.43 | 53,330 | 38,390 | **73,970** | **80,200** | 36,590 | 72.0 |

DOUBLE-RIVETED LAP JOINTS. ⅜″ IRON AND STEEL PLATE.

| | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 68 | F . |  | ⅜″ iron | ⅞″ iron rivets ..... ¾″ punched holes ... | 3.75 | 2.32 | 2.87 | 4.54 | 47,180 | 29,970 | **48,450** | 39,160 | 24,760 | 63.5 |
| 69 | F . . | | ⅜″ iron | ⅞″ iron rivets ..... ¾″ punched holes.... | 3.79 | 2.34 | 2.89 | 4.54 | 47,180 | 31,320 | **50,730** | 41,070 | 26,150 | 66.4 |
| 58 | F . . . | | ⅜″ iron | ⅞″ iron rivets ..... ¾″ punched holes.... | 3.71 | 2.29 | 2.83 | 4.54 | 47,180 | 31,000 | **50,220** | 40,640 | 25,330 | 65.7 |
| 70 | G . |  | ⅜″ iron | ⅞″ iron rivets ..... ¾″ punched holes..... | 3.94 | 2.43 | 2.71 | 4.08 | 47,180 | 28,530 | **46,255** | 41,480 | 27,550 | 60.5 |
| 71 | G . . | | ⅜″ iron | ⅞″ iron rivets ..... ¾″ punched holes ... | 3.87 | 2.39 | 2.67 | 4.08 | 47,180 | 28,475 | **46,110** | 41,270 | 27,010 | 60.4 |
| 81 | I . |  | ⅜″ iron | ⅞″ iron rivets ..... ¾″ drilled holes .... | 5.09 | 3.91 | 2.06 | 3.08 | 47,180 | 23,750 | 30,920 | 58,700 | **39,130** | 50.4 |
| 82 | I . . | | ⅜″ iron | ⅞″ iron rivets ..... ¾″ drilled holes..... | 5.12 | 3.94 | 2.07 | 3.09 | 47,180 | 23,180 | 30,130 | 57,340 | **38,410** | 49.1 |

NOTE.—The figures in larger type indicate the manner of failure. When different kinds of fracture occurred in the same joint, it is indicated by employing larger type in ore than one column.

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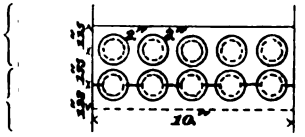
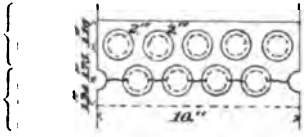
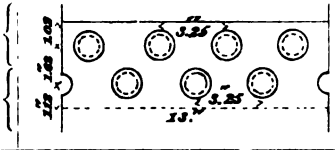
DOUBLE-RIVETED LAP JOINTS, ⅜″ IRON AND STEEL PLATE—Continued.

| Number of tests. | Distinguishing letter. | Style of joint. | Thickness of plate and kind of metal. | Size of rivets and kind of holes. | Sectional area of plate. Gross. | Sectional area of plate. Net. | Bearing surface of rivets. | Shearing area of rivets. | Tensile strength of metal. | Maximum strains on joint, pounds per square inch. Tension on gross area of plate. | Tension on net area of plate. | Compression on bearing surface of rivets. | Shearing on rivets. | Efficiency of joint. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | *Sq. in.* | *Sq. in.* | *Sq. in.* | *Sq. in.* | *Lbs. per sq. in.* | | | | | *Pr. ct.* |
| 57 | F. |  | ⅜″ steel. | ⅞″ iron rivets ..... ¾″ punched holes ... | 3.76 | 2.32 | 2.89 | 4.54 | 53,330 | 39,020 | **62,800** | 50,760 | 32,310 | 73.2 |
| 59 | F.. | | ⅜″ steel. | ⅞″ iron rivets ..... ¾″ punched holes.... | 3.73 | 2.31 | 2.85 | 4.54 | 53,330 | 40,080 | **64,720** | 52,450 | 32,930 | 75.2 |
| 60 | G. |  | ⅜″ steel. | ⅞″ iron rivets ..... ¾″ punched holes.... | 3.63 | 2.24 | 2.49 | 4.08 | 53,330 | 39,010 | **63,210** | 56,360 | 34,710 | 73.2 |
| 61 | G.. | | ⅜″ steel. | ⅞″ iron rivets ..... ¾″ punched holes .. | 3.70 | 2.29 | 2.54 | 4.08 | 53,330 | 34,000 | **54,930** | 49,530 | 30,830 | 63.8 |
| 83 | I. |  | ⅜″ steel. | ⅞″ steel rivets ..... ¾″ drilled holes .... | 4.75 | 3.65 | 1.93 | 3.09 | 53,330 | 34,316 | 44,660 | 84,460 | **52,750** | 64.4 |
| 84 | I.. | | ⅜″ steel. | ⅞″ steel rivets..... ¾″ drilled holes..... | 4.77 | 3.67 | 1.93 | 3.09 | 53,330 | 33,585 | 43,650 | 83,000 | **51,845** | 63.0 |

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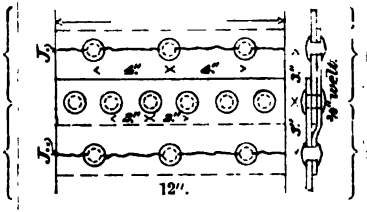
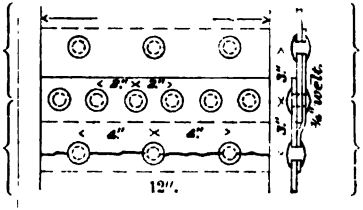
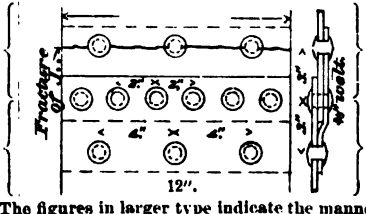
## RIVETED JOINTS, ⅜″ IRON AND STEEL PLATE REINFORCED LAP JOINTS.

| | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 244 | J. |  | ⅜″ iron. | ⅞″ iron rivets ..... ".72 drilled holes.... | 4.63 | 3.80 | 2.50 | 3.66 | 47,180 | 31,900 | 38,870 | 59,080 | **40,360** | 67.6 |
| 245 | J.. | | ⅜″ iron. | ⅞″ iron rivets ..... 1⅛″ drilled holes .... | 4.69 | 3.74 | 2.89 | 4.75 | 47,180 | 34,900 | **43,770** | 56,640 | 34,460 | 74.0 |
| 296 | JJ. |  | ⅜″ iron. | ⅞″ iron rivets ..... 1⅛″ drilled holes .... | 4.51 | 3.59 | 2.78 | 4.75 | 47,180 | 35,700 | **44,840** | 57,910 | 33,890 | 75.7 |
| 297 | JJ.. | | ⅜″ iron. | ⅞″ iron rivets ..... 1⅛″ drilled holes ... | 4.45 | 3.54 | 2.73 | 4.75 | 47,180 | 33,950 | **42,680** | 55,350 | 31,810 | 71.9 |
| 246 | J. |  | ⅜″ steel | ⅞″ steel rivets..... 1⅛″ drilled holes ... | 4.34 | 3.32 | 3.06 | 6.25 | 53,330 | 47,465 | **62,050** | 67,320 | 32,960 | 89.0 |
| 247 | J.. | | ⅜″ steel | ⅞″ steel rivets ..... 1⅛″ drilled holes ... | 4.41 | 3.37 | 3.11 | 6.25 | 53,330 | 48,050 | **62,880** | 68,135 | 33,900 | 90.1 |

NOTE.—The figures in larger type indicate the manner of failure. When different kinds of fracture occurred in the same joint, it is indicated by employing larger type in more than one column.

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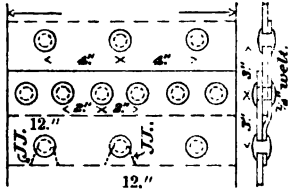
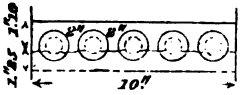
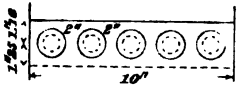
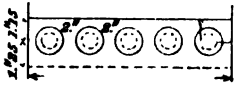
## RIVETED JOINTS, ⅜″ IRON AND STEEL PLATE REINFORCED LAP JOINTS—Continued.

| Number of tests. | Distinguishing letter. | Style of joint. | Thickness of plate and kind of metal. | Size of rivets and kind of holes. | Sectional area of plate. Gross. | Sectional area of plate. Net. | Bearing surface of rivets. | Shearing area of rivets. | Tensile strength of metal. | Maximum strains on joint, pounds per square inch. Tension on gross area of plate. | Tension on net area of plate. | Compression on bearing surface of rivets. | Shearing on rivets. | Efficiency of joint. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | *Sq. in.* | *Sq. in.* | *Sq. in.* | *Sq. in.* | *Lbs. per sq. in.* | | | | | *Pr. ct.* |
| 298 | J J. |   | ⅜″ steel | ⅞″ iron rivets ..... ⅛″ drilled holes .. | 4.47 | 3.43 | 3.11 | 6.11 | 53,330 | 46,820 | 61,020 | **67,300** | **34,250** | 87.8 |
| 299 | J J . . | | ⅜″ steel | ⅞″ iron rivets ..... ⅛″ drilled holes .. | 4.48 | 3.44 | 3.12 | 6.11 | 53,330 | 47,390 | 61,710 | **68,040** | **34,750** | 88.9 |

## SINGLE-RIVETED LAP JOINTS, ⅜″ IRON AND STEEL PLATE.

| | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 240 | A . |   | ⅜″ iron. | ¾″ iron rivets .... ⅞″ punched holes. | 5.095 | 2.91 | 2.18 | 2.64 | 44,615 | 17,760 | **31,100** | 41,500 | 34,280 | 39.8 |
| 241 | A . . | | ⅜″ iron. | ¾″ iron rivets ..... ⅞″ punched holes. | 5.14 | 2.94 | 2.20 | 2.64 | 44,615 | 17,690 | **31,395** | 41,955 | 34,960 | 39.7 |
| 292 | A A . |   | ⅜″ iron. | ¾″ iron rivets ..... ⅞″ drilled holes... | 5.08 | 3.03 | 2.05 | 2.58 | 44,615 | 19,130 | 32,376 | 47,850 | **38,020** | 42.9 |
| 293 | A A . . | | ⅜″ iron. | ¾″ iron rivets ..... ⅞″ drilled holes... | 5.12 | 3.05 | 2.07 | 2.58 | 44,615 | 19,765 | 33,180 | 48,890 | **39,220** | 44.3 |
| 327 | A A A. |   | ⅜″ iron. | ¾″ steel rivets..... ⅞″ drilled holes .. | 5.11 | 3.04 | 2.06 | 2.58 | 44,615 | 28,740 | 39,900 | **58,880** | **47,020** | 52.2 |

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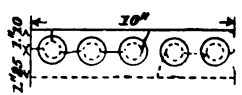
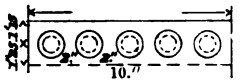
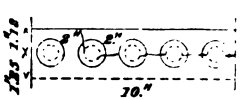
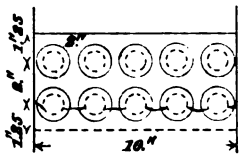
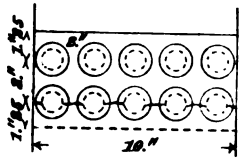
| | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 328 | AAA.. |  | ½" iron. | ⅞" steel rivets..... ⅛" drilled holes... | 5.10 | 8.04 | 2.06 | 2.58 | 44,615 | 24,200 | **40,590** | **59,900** | 47,830 | 54.2 |
| 242 | A . |  | ½" steel | ⅞" iron rivets ..... 1⅛" punched holes. | 4.97 | 2.84 | 2.13 | 2.64 | 57,215 | 21,830 | 38,204 | 50,940 | **41,100** | 38.2 |
| 243 | A . . | | ½" steel | ⅞" iron rivets ..... 1⅛" punched holes. | 4.97 | 2.84 | 2.13 | 2.64 | 57,215 | 20,523 | 35,915 | 47,890 | **38,636** | 35.9 |
| 294 | A A . |  | ½" steel | 1⅛" iron rivets .... 1" punched holes . | 4.93 | 2.40 | 2.536 | 3.93 | 57,215 | 29,310 | **60,210** | 56,980 | **36,770** | 51.2 |
| 295 | AA . . | | ½" steel | 1⅛" iron rivets ... 1" punched holes . | 4.97 | 2.42 | 2.55 | 3.93 | 57,215 | 24,145 | **49,590** | 47,060 | 30,540 | 42.2 |

DOUBLE-RIVETED LAP JOINTS, ½" IRON AND STEEL PLATE.

| | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 329 | C . |  | ½" iron | ¾" iron rivets ..... 1⅛" punched holes | 5.16 | 2.96 | 2.20 | 5.19 | 44,615 | 25,430 | 44,320 | 59,640 | 25,280 | 57.0 |
| 635 | C . . | | ½" iron | ¾" iron rivets ..... 1⅛" punched holes. | 5.17 | 2.97 | 2.20 | 5.19 | 44,615 | 24,660 | 42,920 | 57,950 | 24,560 | 55.2 |
| 619 | C . |  | ½" steel | ⅞ iron rivets ... 1" punched holes . | 5.02 | 2.39 | 5.26 | 7.85 | 57,215 | 30,757 | **64,602** | 29,354 | 19,670 | 53.8 |
| 620 | C . . | | ½" steel | ⅞ iron rivets ..... 1" punched holes.. | 5.01 | 2.39 | 5.25 | 7.85 | 57,215 | 30,778 | **64,519** | 29,371 | 19,644 | 53.8 |

NOTE.—The figures in larger type indicate the manner of failure. When different kinds of fracture occurred in the same joint, it is indicated by employing larger type in more than one column.

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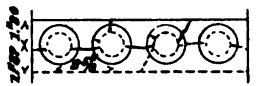
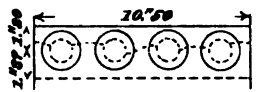
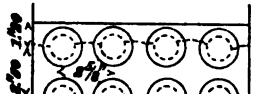
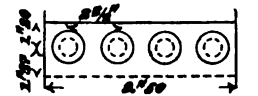
## SINGLE AND DOUBLE RIVETED LAP JOINTS, ⅜" IRON PLATE.

| Number of test. | Distinguishing letter. | Style of joint. | Size of rivets and kind of holes. | Sectional area of plate. Gross. | Sectional area of plate. Net. | Bearing surface of rivets. | Shearing area of rivets. | Tensile strength of metal. | Maximum strains on joint, pounds per square inch. Tension on gross area of plate. | Tension on net area of plate. | Compression on bearing surface of rivets. | Shearing on rivets. | Efficiency of joint. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | *Sq.in.* | *Sq.in.* | *Sq.in.* | *Sq.in.* | *Lbs per sq.in.* | | | | | *Pr. ct.* |
| 730 | A. |  | 1" iron rivets<br>1 1/16" punched holes | 6.29 | 3.63 | 2.65 | 3.55 | 44,635 | 20,020 | **34,680** | 47,510 | 35,460 | 44.9 |
| 731 | A.. |  | 1" iron rivets<br>1 1/16" punched holes | 6.28 | 3.62 | 2.65 | 3.55 | 44,635 | 19,750 | **34,230** | 46,790 | 34,930 | 42.0 |
| 732 | C. |  | 1" iron rivets<br>1 1/16" punched holes | 6.48 | 3.74 | 5.48 | 7.09 | 44,635 | 25,150 | **43,580** | 29,740 | 22,990 | 56.3 |
| 733 | C.. |  | 1" iron rivets<br>1 1/16" punched holes | 6.34 | 3.66 | 5.36 | 7.09 | 44,635 | 26,470 | **45,850** | 31,310 | 23,670 | 59.3 |
| 734 | A. |  | 1" steel rivets<br>1 1/16" punched holes | 5.83 | 3.11 | 2.72 | 3.55 | 52,445 | 26,480 | 49,650 | 56,760 | **43,490** | 50.5 |

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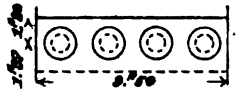
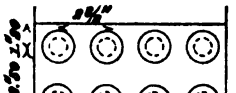
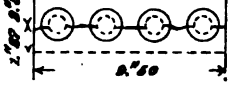
| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 735 | A . . |  | 1″ steel rivets<br>$1\frac{1}{16}$″ punched holes | 5.82 | 3.10 | 2.72 | 3.55 | 52,445 | 28,110 | 52,770 | 60,150 | **46,080** | 58.6 |
| 736 | C . |  | 1″ steel rivets<br>$1\frac{1}{16}$″ punched holes | 5.81 | 3.10 | 5.43 | 7.09 | 52,445 | 37,180 | **69,680** | 39,780 | 30,470 | 76.9 |
| 737 | C . . |  | 1″ steel rivets<br>$1\frac{1}{16}$″ punched holes | 5.81 | 3.10 | 5.43 | 7.09 | 52,445 | 35,800 | **67,100** | 38,300 | 29,340 | 68.3 |

NOTE.—The figures in larger type indicate the manner of failure. When different kinds of fracture occurred in the same joint, it is indicated by employing larger type in more than one column.

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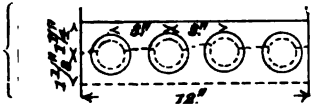
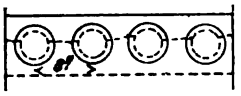
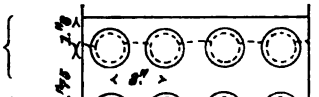
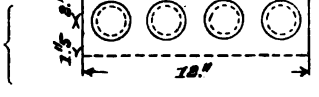
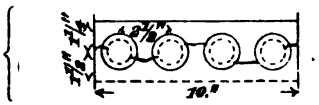
## SINGLE AND DOUBLE RIVETED LAP JOINTS, ¾″ IRON AND STEEL PLATE.

| Number of test. | Distinguishing letter. | Style of joint. | Thickness of plate and kind of metal. | Size of rivets and kind of holes. | Sectional area of plate. Gross. | Sectional area of plate. Net. | Bearing surface of rivets. | Shearing area of rivets. | Tensile strength of metal. | Maximum strains on joint, pounds per square inch. Tension on gross area of plate. | Tension on net area of plate. | Compression on bearing surface of rivets. | Shearing on rivets. | Efficiency of joint. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | *Sq.in.* | *Sq.in.* | *Sq.in.* | *Sq.in.* | *Lbs. per sq. in.* | | | | | *Pr. ct.* |
| 722 | A. |  | ¾″ iron | 1⅛″ iron rivets<br>1 3/16″ punched holes | 8.38 | 4.93 | 3.44 | 4.43 | 46,590 | 17,230 | 29,290 | 41,980 | 32,600 | 37.0 |
| 723 | A.. |  | ¾″ iron | 1⅛″ iron rivets<br>1 3/16″ punched holes | 8.38 | 4.93 | 3.44 | 4.43 | 46,590 | 18,080 | 30,730 | 44,040 | 34,200 | 38.8 |
| 724 | C. |  | ¾″ iron | 1⅛″ iron rivets<br>1 3/16″ punched holes | 8.41 | 4.95 | 6.92 | 8.86 | 46,590 | 24,720 | 42,000 | 30,040 | 23,460 | 53.1 |
| 725 | C.. |  | ¾″ iron | 1⅛″ iron rivets<br>1 3/16″ punched holes | 8.17 | 4.81 | 6.72 | 8.86 | 46,590 | 25,870 | 43,950 | 31,460 | 23,860 | 55.5 |
| 726 | A. |  | ¾″ steel | 1⅛″ steel rivets<br>1 3/16″ punched holes | 7.39 | 3.75 | 3.64 | 4.43 | 51,545 | 20,280 | 39,970 | 41,180 | 33,840 | 39.3 |

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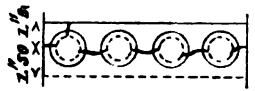
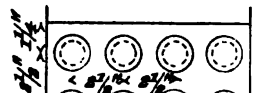
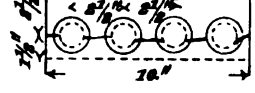
| | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 727 | A . . |  | ½" steel | 1⅛" steel rivets<br>1 15/16" punched holes | 7.38 | 3.78 | 3.64 | 4.43 | 51,545 | 23,940 | 47,370 | 48,540 | 39,890 | 46.4 |
| 728 | C . |  | ½" steel | 1⅛" steel rivets<br>1 15/16" punched holes | 7.33 | 3.70 | 7.25 | 8.86 | 51,545 | 24,720 | 48,970 | 24,990 | 20,450 | 48.0 |
| 729 | C . . |  | ½" steel | 1⅛" steel rivets<br>1 15/16" punched holes | 7.39 | 3.74 | 7.30 | 8.86 | 51,545 | 24,050 | 47,510 | 24,340 | 20,060 | 46.7 |

NOTE.—The figures in larger type indicate the manner of failure. When different kinds of fracture occurred in the same joint, it is indicated by employing larger type in more than one column.

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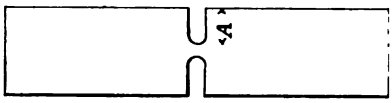
*Tensile tests of $\frac{1}{4}''$ iron and steel grooved specimens.*

To determine the effect upon the tensile strength of the metal, of grooves, punched and drilled, varying in diameter, also varying the width of the specimens at the bottom of the grooves.

FORM OF SPECIMENS.




Each specimen reinforced by the same width of metal, $A=1''.10$, from the bottom of the groove to the side of the plate.

Diameters of drilled grooves: $\frac{1}{4}''$, $\frac{1}{2}''$, $\frac{3}{4}''$, $1''$.

Diameters of punched grooves: Punch $\frac{9}{16}''$, die $\frac{5}{8}''$; punch $\frac{3}{4}''$, die die $\frac{13}{16}''$; punch $1''$, die $1\frac{1}{16}''$.

*Tensile tests of $\frac{1}{4}''$ grooved specimen wrought iron.*

| Number. | Plate. | Diameter of groove. | Width at bottom of groove. | Thickness of plate. | Sectional area. | Ultimate strength. | | Remarks. |
|---|---|---|---|---|---|---|---|---|
| | | | | | | Actual pounds. | Pounds per sq. inch. | |
| | | *Inch.* | *Inch.* | *Inch.* | *Sq. in.* | | | |
| 92 | Punched.. | $\frac{1}{16}$ | .48 | .240 | .115 | 5,530 | 48,090 | |
| 93 | ....do .... | $\frac{1}{16}$ | .46 | .235 | .108 | 5,070 | 46,940 | |
| 94 | ... do ..... | $\frac{1}{4}$ | .46 | .241 | .111 | 5,470 | 49,280 | |
| 95 | ... do .... | $\frac{1}{4}$ | .49 | .240 | .118 | 6,530 | 55,340 | |
| 96 | ....do . .. | 1 | .44 | .239 | .105 | 5,410 | 51,520 | |
| 97 | ....do ..... | 1 | .47 | .241 | .113 | 5,640 | 49,910 | |
| 98 | ... do ..... | $\frac{1}{16}$ | .97 | .247 | .240 | 11,890 | 49,540 | |
| 99 | ....do ..... | $\frac{1}{16}$ | .98 | .247 | .242 | 12,090 | 49,960 | |
| 100 | ....do .... | $\frac{1}{4}$ | .94 | .249 | .234 | 11,730 | 50,128 | |
| 101 | ....do ..... | $\frac{1}{4}$ | .96 | .248 | .238 | 11,160 | 46,900 | |
| 102 | ....do ..... | 1 | .98 | .250 | .245 | 11,510 | 46,980 | |
| 103 | ....do ..... | 1 | .96 | .251 | .241 | 11,170 | 46,350 | |
| 104 | ....do ..... | $\frac{1}{16}$ | 1.47 | .250 | .368 | 13,850 | 37,636 | |
| 105 | ... do ..... | $\frac{1}{16}$ | 1.50 | .252 | .378 | 14,110 | 37,326 | |
| 106 | ....do ..... | $\frac{1}{4}$ | 1.48 | .249 | .369 | 15,140 | 41,030 | |
| 107 | ....do ..... | $\frac{1}{4}$ | 1.48 | .247 | .366 | 14,450 | 39,480 | |
| 108 | ....do ..... | 1 | 1.47 | .250 | .368 | 13,780 | 37,446 | |
| 109 | ....do ..... | 1 | 1.45 | .251 | .364 | 14,390 | 39,533 | |
| 110 | ....do ..... | $\frac{1}{16}$ | 1.96 | .281 | .551 | 23,800 | 43,194 | |
| 111 | ....do ..... | $\frac{1}{16}$ | 1.95 | .274 | .534 | 25,360 | 47,490 | |
| 112 | ....do ..... | $\frac{1}{4}$ | 1.95 | .282 | .550 | 22,750 | 41,360 | |
| 113 | ....do ..... | $\frac{1}{4}$ | 1.92 | .279 | .536 | 23,090 | 43,080 | |
| 114 | ....do ..... | 1 | 2.03 | .250 | .508 | 20,900 | 41,140 | |
| 115 | ....do ..... | 1 | 1.99 | .248 | .494 | 19,550 | 39,575 | |
| 116 | ....do ..... | $\frac{1}{16}$ | 2.42 | .280 | .678 | 24,550 | 36,210 | |
| 117 | ....do ..... | $\frac{1}{16}$ | 2.40 | .245 | .588 | 24,840 | 42,245 | |
| 118 | ....do ..... | $\frac{1}{4}$ | 2.47 | .243 | .600 | 25,340 | 42,233 | |
| 119 | ....do ..... | $\frac{1}{4}$ | 2.46 | .285 | .601 | 25,670 | 42,712 | |
| 120 | ....do ..... | 1 | 2.48 | .245 | .608 | 23,180 | 38,125 | |
| 121 | ....do ..... | 1 | 2.44 | .248 | .605 | 25,180 | 41,620 | |
| 122 | ....do ..... | $\frac{1}{16}$ | 2.97 | .247 | .734 | 28,600 | 38,964 | |
| 123 | ....do ..... | $\frac{1}{16}$ | 2.98 | .241 | .718 | 29,800 | 41,540 | |
| 124 | ....do ..... | $\frac{1}{4}$ | 2.96 | .241 | .713 | 28,500 | 39,972 | |
| 125 | ... do ..... | $\frac{1}{4}$ | 2.92 | .240 | .701 | 29,240 | 41,712 | |
| 126 | ... do ..... | 1 | 2.98 | .250 | .745 | 30,120 | 40,430 | |
| 127 | ....do ..... | 1 | 2.95 | .247 | .729 | 29,780 | 40,850 | |

REMARKS.—The iron plates with punched and drilled grooves show that fractures began at the sides of the grooves for those specimens having a width of $1\frac{1}{2}''$, and wider before the metal separated at the middle of the specimen.

Fractures fibrous.

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*Tensile tests of ¼″ grooved specimen wrought iron.*

| Number. | Plate. | Diameter of groove. | Width at bottom of groove. | Thickness of plate. | Sectional area. | Ultimate strength. Actual pounds. | Ultimate strength. Pounds per sq. inch. | Remarks. |
|---|---|---|---|---|---|---|---|---|
| | | *Inch* | *Inch.* | *Inch.* | *Sq. in.* | | | |
| 128 | Drilled . . | ¼ | .51 | .249 | .127 | 7,085 | 55,787 | |
| 129 | ....do ..... | ¼ | .52 | .245 | .127 | 7,100 | 55,905 | |
| 130 | .. do ..... | ¼ | .52 | .275 | .143 | 8,220 | 57,480 | |
| 131 | ... do ..... | ¼ | .52 | .276 | .144 | 8,060 | 56,000 | |
| 132 | ....do ..... | ¼ | .49 | .248 | .122 | 6,050 | 49,600 | |
| 133 | ....do ..... | ¼ | .50 | .248 | .124 | 7,030 | 56,700 | |
| 134 | ....do ..... | 1 | .47 | .275 | .129 | 7,080 | 54,880 | |
| 135 | ....do ..... | 1 | .51 | .276 | .141 | 8,150 | 57,800 | |
| 136 | .. do ..... | 1 | 1.00 | .276 | .276 | 14,980 | 54,300 | |
| 137 | ... do ..... | 1 | 1.02 | .273 | .278 | 16,040 | 57,700 | |
| 138 | ....do ..... | 1 | 1.00 | .276 | .276 | 14,840 | 53,800 | Seam developed half way across fracture. |
| 139 | ....do . .. | 1 | 1.00 | .280 | .280 | 14,680 | 52,430 | |
| 140 | ....do ..... | 1 | 1.00 | .252 | .252 | 12,450 | 49,400 | |
| 141 | ....do ..... | 1 | 1.02 | .275 | .281 | 15,190 | 54,060 | |
| 142 | .. do ..... | 1 | 1.01 | .247 | .249 | 13,140 | 52,770 | |
| 143 | . do ..... | 1 | 1.00 | .278 | .278 | 15,180 | 54,600 | |
| 144 | ....do ..... | 1 | 1.50 | .276 | .414 | 20,340 | 49,130 | |
| 145 | ....do . .. | 1 | 1.52 | .273 | .415 | 21,290 | 51,300 | |
| 146 | .. do ..... | 1 | 1.48 | .251 | .371 | 17,520 | 47,220 | |
| 147 | ....do . ... | 1 | 1.51 | .273 | .412 | 22,000 | 53,400 | |
| 148 | .. do ..... | 1 | 1.52 | .275 | .418 | 22,650 | 54,180 | |
| 149 | ....do . .. | 1 | 1.50 | .276 | .414 | 22,600 | 54,600 | |
| 150 | ....do ..... | 1 | 1.48 | .274 | .406 | 22,840 | 56,250 | |
| 151 | .. do ..... | 1 | 1.50 | .249 | .374 | 17,300 | 46,260 | |
| 152 | .. do ..... | 1 | 2.01 | .275 | .553 | 25,380 | 45,900 | |
| 153 | ... do ..... | 1 | 2.05 | .279 | .572 | 26,780 | 46,820 | |
| 154 | ... do ..... | 1 | 2.00 | .275 | .550 | 26,370 | 47,950 | |
| 155 | .... do ..... | 1 | 2.00 | .278 | .556 | 27,600 | 49,640 | |
| 156 | .... do ..... | 1 | 2.00 | .286 | .572 | 25,540 | 44,650 | Open weld in rolling at fracture. |
| 157 | ....do ..... | 1 | 2.00 | .275 | .550 | 27,930 | 50,780 | |
| 158 | ....do ..... | 1 | 2.02 | .279 | .564 | 27,550 | 48,850 | |
| 159 | ....do . .. | 1 | 2.00 | .277 | .554 | 27,610 | 49,840 | |
| 160 | ....do .... | 1 | 2.51 | .244 | .612 | 27,530 | 44,980 | |
| 161 | ... do ..... | 1 | 2.52 | .280 | .706 | 28,350 | 40,150 | |
| 162 | ... do .... | 1 | 2.51 | .282 | .708 | 30,550 | 43,150 | |
| 163 | ....do .... | 1 | 2.50 | .244 | .610 | 27,760 | 45,500 | |
| 164 | ....do ..... | 1 | 2.51 | .285 | .715 | 33,240 | 46,500 | Small open weld in rolling at fracture. |
| 165 | ....do ..... | 1 | 2.49 | .242 | .603 | 29,860 | 49,520 | |
| 166 | ....do ..... | 1 | 2.49 | .242 | .603 | ..... | ..... | |
| 167 | ....do ..... | 1 | 2.50 | .280 | .700 | 31,350 | 44,780 | |
| 168 | ....do ..... | 1 | 3.02 | .250 | .755 | 34,500 | 45,700 | |
| 169 | ....do ..... | 1 | 3.02 | .249 | .752 | 33,740 | 44,870 | |
| 170 | ....do ..... | 1 | 3.00 | .240 | .720 | 33,670 | 46,760 | |
| 171 | ....do . .... | 1 | 3.00 | .250 | .750 | 34,280 | 45,700 | |
| 172 | ....do ..... | 1 | 2.93 | .242 | .709 | 34,000 | 47,950 | |
| 173 | ....do ..... | 1 | 2.99 | .250 | .748 | 36,460 | 48,740 | |
| 174 | ....do ..... | 1 | 2.98 | .279 | .831 | 38,140 | 45,900 | |
| 175 | ....do ..... | 1 | 3.01 | .281 | .846 | 37,570 | 44,410 | |

*Tensile tests of ¼″ grooved specimens steel plate.*

| Number. | Plate. | Diameter of groove. | Width at bottom of groove. | Thickness of plate. | Sectional area. | Ultimate strength. Actual pounds. | Ultimate strength. Pounds per sq. inch. | Remarks. |
|---|---|---|---|---|---|---|---|---|
| | | *Inch* | *Inch.* | *Inch.* | *Sq. in.* | | | |
| 176 | Punched.. | 9/16 | .49 | .250 | .123 | 8,010 | 65,120 | |
| 177 | ... do ..... | 9/16 | .47 | .249 | .117 | 7,840 | 67,010 | |
| 178 | ....do ..... | ¼ | .48 | .249 | .120 | 7,610 | 63,420 | |
| 179 | ....do ..... | ¼ | .48 | .248 | .119 | 7,920 | 66,550 | |
| 180 | ....do ..... | 1 | .48 | .247 | .119 | 7,980 | 67,060 | |
| 181 | ....do ..... | 1 | .47 | .248 | .117 | 7,640 | 65,300 | |
| 182 | ....do ..... | 9/16 | .99 | .249 | .246 | 14,720 | 59,840 | |
| 183 | ....do ..... | 9/16 | 1.00 | .250 | .250 | 15,540 | 62,160 | |
| 184 | ....do ..... | ¼ | 1.01 | .249 | .251 | 17,130 | 68,246 | |
| 185 | ....do ..... | ¼ | .96 | .250 | .240 | 16,160 | 67,330 | |
| 186 | ....do ..... | 1 | .96 | .248 | .238 | 15,700 | 65,966 | |
| 187 | ....do ..... | 1 | .95 | .245 | .233 | 14,610 | 62,700 | |
| 188 | ....do ..... | 9/16 | 1.45 | .248 | .360 | 23,070 | 64,080 | |
| 189 | ....do ..... | ¼ | 1.45 | .252 | .365 | 23,360 | 64,000 | |

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*Tensile tests of ¼″ grooved specimens steel plate*—Continued.

| Number. | Plate. | Diameter of groove. | Width at bottom of groove. | Thickness of plate. | Sectional area. | Ultimate strength. Actual pounds. | Ultimate strength. Pounds per sq. inch. | Remarks. |
|---|---|---|---|---|---|---|---|---|
| | | *Inch.* | *Inch.* | *Inch.* | *Sq. in.* | | | |
| 190 | ....do ..... | 1 | 1.45 | .249 | .361 | 22,030 | 61,025 | |
| 191 | ....do ..... | 1 | 1.51 | .251 | .379 | 22,520 | 59,420 | |
| 192 | ....do ..... | ⅞ | 1.96 | .250 | .490 | 29,350 | 59,900 | |
| 193 | ....do ..... | ⅞ | 1.93 | .252 | .486 | 30,860 | 63,500 | |
| 194 | ....do ..... | 1 | 1.98 | .250 | .495 | 29,380 | 59,350 | |
| 195 | ....do ..... | 1 | 1.96 | .251 | .492 | 29,060 | 59,060 | |
| 196 | ....do ..... | ⅞ | 2.49 | .249 | .620 | 36,020 | 58,100 | |
| 197 | ....do ..... | ¼ | 2.47 | .249 | .615 | 39,300 | 63,900 | |
| 198 | ....do ..... | 1 | 2.43 | .250 | .608 | 37,450 | 61,640 | |
| 199 | ....do ..... | ⅛ | 2.95 | .251 | .740 | 41,830 | 56,530 | Specimen tore apart from one edge. |
| 200 | ....do ..... | ⅛ | 3.01 | .249 | .749 | 44,030 | 58,780 | |
| 201 | ....do ..... | ⅛ | 3.04 | .253 | .769 | 42,680 | 55,500 | |
| 202 | ....do ..... | ¼ | 2.97 | .252 | .748 | 44,920 | 60,060 | |
| 203 | ....do ..... | 1 | 2.98 | .251 | .748 | 40,430 | 54,050 | |
| 204 | ....do ..... | 1 | 2.97 | .249 | .740 | 41,470 | 56,040 | |

Above fractures, silky appearance. Specimens 1″ wide fracture at the sides of the groove before breaking at the center. The same remarks apply to all specimens above 1″ in width.

Specimens ½″ wide at bottom of groove break square across, leaving the fractured ends straight.

*Tensile tests of ¼″ grooved specimens steel plate.*

| Number. | Plate. | Diameter of groove. | Width at bottom of groove. | Thickness of plate. | Sectional area. | Ultimate strength. Actual pounds. | Ultimate strength. Pounds per sq. inch. | Area at fracture. | Contraction of area. |
|---|---|---|---|---|---|---|---|---|---|
| | | *Inch.* | *Inch.* | *Inch.* | *Sq. in.* | | | | *Pr. ct.* |
| 205 | Drilled.... | ¼ | .52 | .246 | .128 | 8,690 | 67,890 | | |
| 206 | ...do ..... | ¼ | .54 | .248 | .134 | 9,000 | 67,160 | ".47×".12 −.056 square inch.... | 58.2 |
| 207 | ....do ..... | ¼ | .53 | .247 | .131 | 8,760 | 66,870 | | |
| 208 | ....do ..... | ¼ | .50 | .247 | .123 | 8,070 | 65,610 | | |
| 209 | ....do ..... | ¼ | .51 | .249 | .127 | 8,430 | 66,370 | | |
| 210 | ... do ..... | ¼ | .51 | .250 | .128 | 8,630 | 67,420 | | |
| 211 | ... do ..... | 1 | .52 | .248 | .129 | 8,740 | 67,750 | | |
| 212 | ....do ..... | 1 | .52 | .252 | .131 | 8,110 | 61,910 | ".41×".12=.049 square inch.... | 62.6 |
| 213 | ....do ..... | ¼ | 1.03 | .247 | .254 | 17,040 | 67,090 | | |
| 214 | ....do ..... | ¼ | 1.02 | .250 | .255 | 16,930 | 66,390 | ".95×".13=.124 square inch.... | 51.4 |
| 215 | ....do ..... | ¼ | 1.02 | .246 | .251 | 16,760 | 66,770 | | |
| 216 | ....do ..... | ¼ | 1.02 | .250 | .255 | 17,270 | 67,730 | ".92×".13=.120 square inch.... | 53.0 |
| 217 | ....do ..... | ¼ | 1.01 | .247 | .249 | 16,440 | 66,020 | | |
| 218 | ....do ..... | ¼ | 1.00 | .251 | .251 | 16,820 | 67,010 | ".90×".13=.117 square inch.... | 53.4 |
| 219 | ....do ..... | 1 | 1.00 | .247 | .247 | 15,920 | 64,450 | | |
| 220 | ....do ..... | 1 | 1.01 | .250 | .253 | 16,720 | 66,090 | ".89×".13=.116 square inch.... | 54.1 |
| 221 | ....do ..... | ¼ | 1.54 | .250 | .385 | 24,790 | 64,390 | | |
| 222 | ....do ..... | ¼ | 1.52 | .251 | .382 | 24,200 | 63,350 | | |
| 223 | ....do ..... | ¼ | 1.50 | .253 | .380 | 24,460 | 64,370 | | |
| 224 | ....do ..... | 1 | 1.54 | .248 | .382 | 24,790 | 64,895 | | |
| 225 | ....do ..... | ¼ | 2.02 | .252 | .509 | 32,740 | 64,320 | | |
| 226 | ....do ..... | ¼ | 2.00 | .251 | .502 | 31,610 | 62,970 | | |
| 227 | ....do ..... | 1 | 2.02 | .251 | .507 | 30,880 | 60,910 | | |
| 228 | ....do ..... | ¼ | 2.50 | .248 | .620 | 36,740 | 59,260 | | |
| 229 | ....do ..... | ¼ | 2.50 | .252 | .630 | 39,850 | 63,250 | | |
| 230 | ....do ..... | 1 | 2.53 | .248 | .627 | 37,240 | 59,390 | | |
| 231 | ....do ..... | ¼ | 3.03 | .251 | .761 | 46,860 | 61,577 | | |
| 232 | ....do ..... | ¼ | 3.00 | .249 | .747 | 44,130 | 59,080 | | |
| 233 | ....do ..... | ¼ | 3.02 | .251 | .758 | 45,140 | 59,550 | | |
| 234 | ...do ..... | ¼ | 3.02 | .250 | .755 | 45,070 | 59,700 | | |
| 235 | ....do ..... | ¼ | 3.00 | .250 | .750 | 47,530 | 63,370 | | |
| 236 | ....do ..... | 1 | 3.00 | .251 | .753 | 44,150 | 58,630 | | |
| 237 | ....do ..... | 1 | 3.03 | .252 | .764 | 48,850 | 63,940 | | |

Above fractures silky in appearance.

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*Tensile tests of ¼″ grooved specimens steel plate*—Continued.

| Number. | Plate. | Diameter of groove. | Width at bottom of groove. | Thickness of plate. | Sectional area. | Ultimate strength. Actual pounds. | Ultimate strength. Pounds per sq. inch. | Remarks. |
|---|---|---|---|---|---|---|---|---|
| | | *Inch* | *Inch.* | *Inch.* | *Sq. in.* | | | |
| 190 | ....do ..... | 1 | 1.45 | .249 | .361 | 22,030 | 61,025 | |
| 191 | ....do ..... | 1 | 1.51 | .251 | .379 | 22,520 | 59,420 | |
| 192 | ....do ..... | 1 | 1.96 | .250 | .490 | 29,350 | 59,900 | |
| 193 | ... do ..... | 1 | 1.93 | .252 | .486 | 30,860 | 63,500 | |
| 194 | ....do ..... | 1 | 1.98 | .250 | .495 | 29,380 | 59,350 | |
| 195 | ... do ..... | 1 | 1.96 | .251 | .492 | 29,060 | 59,060 | |
| 196 | ....do ..... | 1 | 2.49 | .249 | .620 | 36,020 | 58,100 | |
| 197 | ... do ..... | 1 | 2.47 | .249 | .615 | 39,300 | 63,900 | |
| 198 | ... do ..... | 1 | 2.43 | .250 | .608 | 37,460 | 61,640 | |
| 199 | ... do ..... | 1 | 2.95 | .251 | .740 | 41,830 | 56,530 | Specimen tore apart from one edge. |
| 200 | ....do ..... | 1 | 3.01 | .249 | .749 | 44,030 | 58,780 | |
| 201 | ....do ..... | 1 | 3.04 | .253 | .769 | 42,680 | 55,500 | |
| 202 | ....do ..... | 1 | 2.97 | .252 | .748 | 44,920 | 60,060 | |
| 203 | ....do ..... | 1 | 2.98 | .251 | .748 | 40,430 | 54,050 | |
| 204 | ....do ..... | 1 | 2.97 | .249 | .740 | 41,470 | 56,040 | |

Above fractures, silky appearance. Specimens 1″ wide fracture at the sides of the groove before breaking at the center. The same remarks apply to all specimens above 1″ in width.

Specimens ½″ wide at bottom of groove break square across, leaving the fractured ends straight.

*Tensile tests of ¼″ grooved specimens steel plate.*

| Number. | Plate. | Diameter of groove. | Width at bottom of groove. | Thickness of plate. | Sectional area. | Ultimate strength. Actual pounds. | Ultimate strength. Pounds per sq. inch. | Area at fracture. | Contraction of area. |
|---|---|---|---|---|---|---|---|---|---|
| | | *Inch.* | *Inch.* | *Inch.* | *Sq. in.* | | | | *Pr. ct.* |
| 205 | Drilled.... | ¼ | .52 | .246 | .128 | 8,690 | 67,890 | | |
| 206 | ....do ..... | ¼ | .54 | .248 | .134 | 9,000 | 67,160 | ″.47 × ′.12 = .056 square inch.... | 58.2 |
| 207 | ....do ..... | ¼ | .53 | .247 | .131 | 8,760 | 66,870 | | |
| 208 | ....do ..... | ¼ | .50 | .247 | .123 | 8,070 | 65,610 | | |
| 209 | ....do ..... | ¼ | .51 | .249 | .127 | 8,430 | 66,370 | | |
| 210 | ... do ..... | ¼ | .51 | .250 | .128 | 8,630 | 67,420 | | |
| 211 | ... do ..... | 1 | .52 | .248 | .129 | 8,740 | 67,750 | | |
| 212 | ....do ..... | 1 | .52 | .252 | .131 | 8,110 | 61,910 | ″.41 × ″.12 = .049 square inch.... | 62.6 |
| 213 | ....do ..... | ¼ | 1.03 | .247 | .254 | 17,040 | 67,090 | | |
| 214 | ....do ..... | ¼ | 1.02 | .250 | .255 | 16,930 | 66,390 | ″.95 × ″.13 = .124 square inch.... | 51.4 |
| 215 | ....do ..... | ¼ | 1.02 | .246 | .251 | 16,760 | 66,770 | | |
| 216 | ....do ..... | ¼ | 1.02 | .250 | .255 | 17,270 | 67,730 | ″.92 × ″.13 = .120 square inch.... | 53.0 |
| 217 | ....do ..... | ¼ | 1.01 | .247 | .249 | 16,440 | 66,020 | | |
| 218 | ....do ..... | ¼ | 1.00 | .251 | .251 | 16,820 | 67,010 | ″.90 × ″.13 = .117 square inch.... | 53.4 |
| 219 | ....do ..... | 1 | 1.00 | .247 | .247 | 15,920 | 64,450 | | |
| 220 | ....do ..... | 1 | 1.01 | .250 | .253 | 16,720 | 66,090 | ″.89 × ″.13 = .116 square inch.... | 54.1 |
| 221 | ....do ..... | ¼ | 1.54 | .250 | .385 | 24,790 | 64,390 | | |
| 222 | ....do ..... | ¼ | 1.52 | .251 | .382 | 24,200 | 63,350 | | |
| 223 | ....do ..... | ¼ | 1.50 | .253 | .380 | 24,460 | 64,370 | | |
| 224 | ....do ..... | 1 | 1.54 | .248 | .382 | 24,790 | 64,895 | | |
| 225 | ....do ..... | ¼ | 2.02 | .252 | .509 | 32,740 | 64,320 | | |
| 226 | ....do ..... | ¼ | 2.00 | .251 | .502 | 31,610 | 62,970 | | |
| 227 | ....do ..... | 1 | 2.02 | .251 | .507 | 30,880 | 60,910 | | |
| 228 | ....do ..... | ¼ | 2.50 | .248 | .620 | 36,740 | 59,260 | | |
| 229 | ....do ..... | ¼ | 2.50 | .252 | .630 | 39,850 | 63,250 | | |
| 230 | ....do ..... | 1 | 2.53 | .248 | .627 | 37,240 | 59,390 | | |
| 231 | ....do ..... | ¼ | 3.03 | .251 | .761 | 46,860 | 61,577 | | |
| 232 | ....do ..... | ¼ | 3.00 | .249 | .747 | 44,130 | 59,080 | | |
| 233 | ....do ..... | ¼ | 3.02 | .251 | .758 | 45,140 | 59,550 | | |
| 234 | ....do ..... | ¼ | 3.02 | .250 | .755 | 45,070 | 59,700 | | |
| 235 | ....do ..... | ¼ | 3.00 | .250 | .750 | 47,530 | 63,370 | | |
| 236 | ....do ..... | 1 | 3.00 | .251 | .753 | 44,150 | 58,630 | | |
| 237 | ....do ..... | 1 | 3.03 | .252 | .764 | 48,850 | 63,940 | | |

Above fractures silky in appearance.

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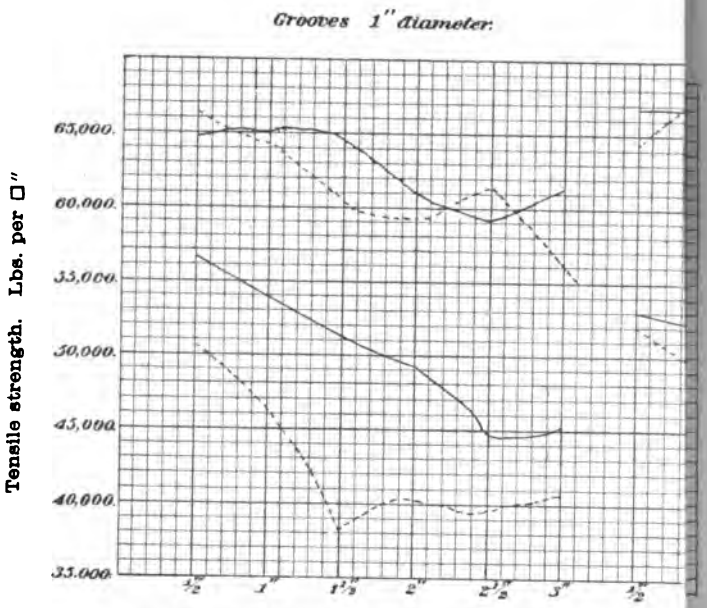


S. Ex. 1——face p. 145——2

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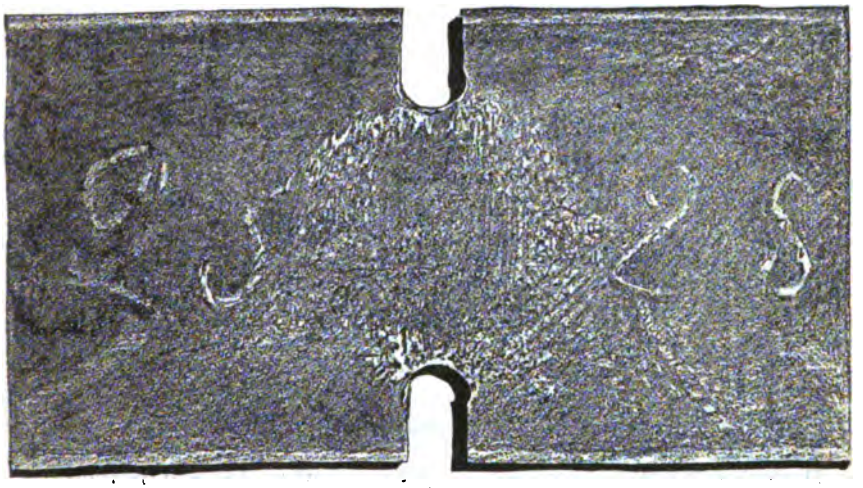
REMARKS.—Specimens with $\frac{1}{4}''$ groove $1''$ wide fracture first at sides, thence tearing to the center of the part tested.

Specimens with $\frac{1}{2}''$ groove $1''$ wide break square across, the fracture taking place at the same time over the full width.

Specimens with $\frac{3}{4}''$ groove fractured in the same manner as the $\frac{1}{2}''$ grooved ones.

Specimens with $1''$ groove $1''$ wide separate first at the middle.

Specimens $3''$ wide all fractured irregular across plate, those with narrow grooves showing the greatest convexity of fractured ends.



Photograph of grooved specimen, No. 229, showing the developement of "Cooper lines."

The test of this specimen was discontinued after the ultimate strength had been determined and before fracture took place.



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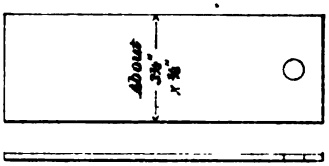
*Tests to determine the ultimate resistance of plate steel to tearing out at rivet holes.*

## ¼″ STEEL PLATE.

Quality of metal from tensile test:
Elastic limit, 40,860 pounds per square inch.
Ultimate strength, 55,760 pounds per square inch.
Uniform elongation after fracture, 20 per cent.
Contraction of area at fracture, 56.5 per cent.
Appearance of fracture, silky.
Steel plate of ¼″ nominal thickness of the form shown by sketch.




⅝″ drilled hole spaced at distance *A* from the end of plate. Value of *A* running from 1″ to 2″, advancing by ¼″. 2 specimens of a kind.
⅝″ steel pin used in ⅝″ holes.

### No. 469.

Distance from center of hole to edge of plate, 1″.
Thickness of plate, ″.246.
Diameter of hole × thickness = ″.625 × ″.246 = .154 square inch.

| Loads applied. | Elongation of hole. | Permanent elongation of hole. | Remarks. |
|---|---|---|---|
| *Pounds.* | *Inch.* | *Inch.* | |
| 3,500 | .01 | 0. | Loads released to measure permanent elongation of hole. |
| 5,000 | No further change. | | |
| 7,000 | .01+ | About .00½ | Color changes front of hole. |
| 8,000 | .02 | ..... | Color changes front of hole; wider strip covers. |
| 9,000 | .02½ | .01 | Scale starts front of hole. |
| 10,000 | .04 | .02½ | |
| 12,000 | .06 | .05 | |
| 13,000 | .08 | ..... | |
| 14,000 | .11 | .10 | Hole widens transversely about ″.00½. |
| 15,000 | .15 | ..... | |
| 16,000 | .27 | ..... | |
| 16,150 | ..... | .34 | Depth front of hole, ″.57, showing a reduction of ″.11. |
| 16,200 | ..... | ..... | Ultimate strength = 105,100 pounds per square inch on the compression area of hole. |

Test discontinued before the metal separated front of hole, the permanent elongation of the hole having reached ″.48.

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## No. 470.

Duplicate of No. 469.
Thickness of plate, ″.250.
Diameter of hole × thickness (″.625 × .250) = .156 square inch.

| Loads applied. | Elongation of hole. | Remarks. |
|---|---|---|
| *Pounds.* | *Inch.* | |
| 3,300 | .00½ | |
| 4,200 | .01 | |
| 8,800 | .02 | |
| 10,500 | .03 | |
| 12,000 | .05 | |
| 13,000 | .07 | |
| 14,000 | .11 | |
| 15,000 | .16 | |
| 16,380 | .38 | Ultimate strength = 105,000 pounds per square inch compression. |

## No. 471.

Thickness of plate, ———.
Distance from center of $\frac{5}{8}$″ hole to end of plate, 1″.23.
Compression area, ″.250 × ″.625 = .156 square inch.
Micrometer dial applied for getting measurements.

| Loads applied. | Elongation of hole. | Permanent elongation of hole. | Remarks. |
|---|---|---|---|
| *Pounds.* | *Inch.* | *Inch.* | |
| 1,000 | 0. | ..... | |
| 1,500 | .0006 | ..... | |
| 1,000 | ..... | .0004 | |
| 2,000 | .0011 | ..... | |
| 2,500 | .0016 | ..... | |
| 3,000 | .0022 | ..... | |
| 3,500 | .0029 | ..... | |
| 1,000 | ..... | .0010 | |
| 4,000 | .0034 | ..... | |
| 4,500 | .0041 | ..... | |
| 5,000 | .0046 | ..... | |
| 1,000 | ..... | .0011 | |
| 5,500 | .0052 | ..... | |
| 6,000 | .0061 | ..... | |
| 6,500 | .0071 | ..... | |
| 7,000 | .0077 | ..... | |
| 7,500 | .0086 | ..... | |
| 8,000 | .0093 | ..... | |
| 8,500 | .0101 | ..... | |
| 9,000 | .0113 | ..... | |
| 9,500 | .0129 | ..... | |
| 10,000 | .0143 | ..... | |
| 1,000 | ..... | .0082 | |
| 10,500 | .0171 | ..... | |
| 11,000 | .0199 | ..... | |
| 12,000 | .0300 | ..... | |
| 13,000 | .043 | ..... | |
| 14,000 | .061 | ..... | |
| 15,000 | .083 | ..... | |
| 16,000 | .114 | ..... | |
| 20,400 | ..... | ..... | Ultimate strength = 130,770 pounds per square inch compression. |

Fracture began at sides of hole.
Total elongation when maximum strain was reached, about ″.62½

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## No. 472.

Duplicate of No. 471.
Thickness of plate, ″.249.
Distance from center of $\frac{5}{8}$″ hole to end of plate, 1″.29.
Compression area, .156 square inch.

| Loads applied. | Elongation of hole. | Permanent elongation of hole. | Remarks. |
|---|---|---|---|
| *Pounds.* | *Inch.* | *Inch.* | |
| 1,000 | 0. | ..... | |
| 5,000 | .0080 | ..... | |
| 7,000 | .0120 | ..... | |
| 8,000 | .0150 | ..... | |
| 1,000 | ..... | .0100 | |
| 9,000 | .0175 | ..... | |
| 9,500 | .019 | ..... | |
| 10,000 | .021 | ..... | |
| 10,500 | .023 | ..... | |
| 11,000 | .026 | ..... | |
| 11,500 | .030 | ..... | |
| 12,000 | .037 | ..... | |
| 12,500 | .044 | ..... | |
| 13,000 | .052 | ..... | |
| 13,500 | .060 | ..... | |
| 14,000 | .071 | ..... | |
| 15,000 | .096 | ..... | |
| 20,180 | ..... | ..... | Ultimate strength=129,360 pounds per square inch compression. |

Fracture began at end of plate, front of hole, when elongation of hole had reached ″.57.

## No. 473.

Thickness of plate, ″.250.
Distance from center of $\frac{5}{8}$″ hole to end of plate, 1″.51.
Compression area, .156 square inch.

| Loads applied. | Elongation of hole. | Permanent elongation of hole. | Remarks. |
|---|---|---|---|
| *Pounds.* | *Inch.* | *Inch.* | |
| 1,000 | 0. | ..... | |
| 5,000 | .0075 | ..... | |
| 10,000 | .0181 | ..... | |
| 1,000 | ..... | .0125 | |
| 11,000 | .0220 | ..... | |
| 11,500 | .0240 | ..... | |
| 12,000 | .0268 | ..... | |
| 12,500 | .0308 | ..... | |
| 13,000 | .034 | ..... | |
| 13,500 | .040 | ..... | |
| 14,000 | .047 | ..... | |
| 14,500 | .055 | ..... | |
| 15,000 | .064 | ..... | |
| 15,500 | .074 | ..... | |
| 23,900 | ..... | ..... | Ultimate strength=153,200 pounds per square inch compression. |

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No. 474.

Duplicate of No. 473.
Thickness of plate, ″.253.
Distance from center of hole to end of plate, 1″.51.
Compression area, .160 square inch.

| Loads applied. | Elongation of hole. | Permanent elongation of hole. | Remarks. |
|---|---|---|---|
| *Pounds.* | *Inch.* | *Inch.* | |
| 1,000 | 0. | ..... | NOTE.—The shape of the specimen after fracture appears to indicate that the ultimate strength is somewhat lower than would be attained if the specimen was wider, so as to prevent the metal from widening the test piece at the end. |
| 5,000 | .0050 | ..... | |
| 10,000 | .0156 | ..... | |
| 1,000 | ..... | .0096 | |
| 11,000 | .0195 | ..... | |
| 12,000 | .0250 | ..... | |
| 12,500 | .0285 | ..... | |
| 13,000 | .0325 | ..... | |
| 13,500 | .0385 | ..... | |
| 14,000 | .0447 | ..... | |
| 14,500 | .0523 | ..... | |
| 15,000 | .0610 | ..... | |
| 15,500 | .0703 | ..... | |
| 16,000 | .0805 | ..... | |
| 17,000 | .1030 | ..... | |
| 18,000 | .131 | ..... | |
| 19,000 | .165 | ..... | |
| 20,000 | .208 | ..... | |
| 21,000 | .264 | ..... | |
| 22,000 | .346 | ..... | |
| 24,700 | ..... | ..... | Ultimate strength = 154,370 pounds per square inch compression. |

Failed the same as No. 473, by the metal front of the hole tearing apart.

No. 475.

Thickness of plate, ″.246.
Distance from center of hole to end of plate, 1″.75.
Compression area, .154 square inch.

| Loads applied. | Elongation of hole. | Permanent elongation of hole. | Remarks. |
|---|---|---|---|
| *Pounds.* | *Inch.* | *Inch.* | |
| 1,000 | 0. | ..... | |
| 10,000 | .0172 | ..... | |
| 1,000 | ..... | .0118 | |
| 10,500 | .0190 | ..... | |
| 11,000 | .0208 | ..... | |
| 11,500 | .0230 | ..... | |
| 12,000 | .0258 | ..... | |
| 12,500 | .0282 | ..... | |
| 13,000 | .0315 | ..... | |
| 13,500 | .0350 | ..... | |
| 14,000 | .0390 | ..... | |
| 14,500 | .0435 | ..... | |
| 15,000 | .0490 | ..... | |
| 15,500 | .0545 | ..... | |
| 16,000 | .0620 | ..... | |
| 16,500 | .0700 | ..... | |
| 17,000 | .0785 | ..... | |
| 28,700 | ..... | ..... | Ultimate strength = 186,360 pounds per square inch compression. |

Failed by tension at end of plate, front of hole, and also shearing at sides of hole.

Scale disturbed the full width (3½″) of the plate on either side of the hole.

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No. 476.

Duplicate of No. 475.
Thickness of plate, ″.249.
Distance from center of hole to end of plate, 1″.73.
Compression area, 1.56 square inches.

| Loads applied. | Elongation of hole. | Permanent elongation of hole. | Remarks. |
|---|---|---|---|
| *Pounds.* | *Inch.* | *Inch.* | |
| 1,000 | 0. | ..... | |
| 10,000 | .0216 | ..... | |
| 1,000 | ..... | .0158 | |
| 12,000 | .0330 | ..... | |
| 12,500 | .0360 | ..... | |
| 13,000 | .0410 | ..... | |
| 13,500 | .0455 | ..... | |
| 14,000 | .0515 | ..... | |
| 14,500 | .0580 | ..... | |
| 15,000 | .0660 | ..... | |
| 15,500 | .0740 | ..... | |
| 16,000 | .0845 | ..... | |
| 16,500 | .0950 | ..... | |
| 17,000 | .1060 | ..... | |
| 17,500 | .1182 | ..... | |
| 18,000 | .1320 | ..... | |
| 27,500 | ..... | ..... | Ultimate strength=176,280 pounds per square inch compression. |

Tore apart front of hole, fracture beginning at the end of the plate; sheared out piece, width about §″.

The manner of failure probably would have been different with a wider specimen, as this specimen widened at the end in a marked manner.

No. 477.

Thickness of plate, ″.248.
Distance from center of hole to end of plate, 1″.98.
Compression area, .155 square inch.

| Loads applied. | Elongation of hole. | Permanent elongation of hole. | Remarks. |
|---|---|---|---|
| *Pounds.* | *Inch.* | *Inch.* | |
| 1,000 | 0. | ..... | |
| 10,000 | .0162 | ..... | |
| 1,000 | ..... | .0110 | |
| 12,000 | .0252 | ..... | |
| 12,500 | .0282 | ..... | |
| 13,000 | .0315 | ..... | |
| 13,500 | .0350 | ..... | |
| 14,000 | .0390 | ..... | |
| 14,500 | .0435 | ..... | |
| 15,000 | .0480 | ..... | |
| 15,500 | .0530 | ..... | |
| 16,000 | .0590 | ..... | |
| 16,500 | .0650 | ..... | |
| 17,000 | .0712 | ..... | |
| 17,500 | .0788 | ..... | |
| 18,000 | .0870 | ..... | |
| 18,500 | .0968 | ..... | |
| 19,000 | .1080 | ..... | |
| 31,800 | ..... | ..... | Ultimate strength=205,160 pounds per square inch compression. |

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No. 478.

Duplicate of No. 477.
Thickness of plate, ".248.
Distance from center of §" hole to end of plate, 1".99.
Compression area, 1.55 square inches.

| Loads applied. | Elongation of hole. | Permanent elongation of hole. | Remarks. |
|---|---|---|---|
| *Pounds.* | *Inch.* | *Inch.* | |
| 1,000 | 0. | | |
| 10,000 | .0222 | | |
| 1,000 | | .0165 | |
| 12,000 | .0330 | | |
| 13,000 | .0400 | | |
| 13,500 | .0445 | | |
| 14,000 | .0490 | | |
| 14,500 | .0550 | | |
| 15,000 | .0600 | | |
| 15,500 | .0662 | | |
| 16,000 | .0738 | | |
| 16,500 | .0820 | | |
| 17,000 | .0915 | | |
| 17,500 | .1015 | | |
| 18,000 | .1120 | | |
| 31,050 | | | Ultimate strength=200,320 pounds per square inch compression. |

*Details of riveted joints.*

STEEL PLATES—PUNCHED HOLES.

Steel plates, from No. 469 to No. 478, inclusive, punched 11".16 holes for §" rivets through opposite end to that drilled.

The specimens were riveted together in pairs, and afterwards the rivet heads were planed off and the rivets driven out.

This leaves the punched holes in substantially the condition they are used in practice.

A steel pin, ".70 diameter, is used through the holes.

Punched holes in specimens Nos. 479 to 483, inclusive, and Nos. 401 to 405, inclusive.

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No. 479.

Distance from center of hole to end of plate, 1″.05.
Diameter of hole, ″.71.
Thickness of plate, 2″.46.
Compression area, ″.246 × ″.70 = .172 square inch.
End of plate was sheared.

| Loads applied. | Elongation of hole. | Permanent elongation of hole. | Remarks. |
|---|---|---|---|
| *Pounds.* | *Inch.* | *Inch.* | |
| 1,000 | ..... | ..... | |
| 2,000 | .0022 | ..... | |
| 3,000 | .0040 | ..... | |
| 4,000 | .0060 | ..... | |
| 5,000 | .0077 | ..... | |
| 1,000 | ..... | .0042 | |
| 6,000 | .0097 | ..... | |
| 6,500 | .0104 | ..... | |
| 7,000 | .0114 | ..... | |
| 7,500 | .0123 | ..... | |
| 8,000 | .0132 | ..... | |
| 8,500 | .0142 | ..... | |
| 9,000 | .0151 | ..... | |
| 9,500 | .0160 | ..... | |
| 10,000 | .0170 | ..... | |
| 10,500 | .0180 | ..... | |
| 11,000 | .0190 | ..... | |
| 11,500 | .0201 | ..... | |
| 12,000 | .0213 | ..... | |
| 12,500 | .0222 | ..... | |
| 13,000 | .0252 | ..... | |
| 13,500 | .0280 | ..... | |
| 14,000 | .0323 | ..... | |
| 14,500 | .0392 | ..... | |
| 15,000 | .0502 | ..... | |
| 15,500 | .0692 | ..... | |
| 16,000 | .1024 | ..... | |
| 16,500 | .1502 | ..... | |
| 17,000 | .2202 | ..... | |
| 17,150 | .3050 | ..... | Ultimate strength = 99,710 pounds per square inch compression. |

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## No. 480.

Distance from center of hole to end of plate, 1″.02.
End of plate planed.
Thickness of plate, ″.250.
Compression of area, .175 square inch.

| Loads applied. | Elongation of hole. | Remarks. |
|---|---|---|
| *Pounds.* | *Inch.* | |
| 1,000 | 0. | |
| 5,000 | .0064 | |
| 8,000 | .0100 | |
| 8,500 | .0104 | |
| 9,000 | .0112 | |
| 9,500 | .0118 | |
| 10,000 | .0124 | |
| 10,500 | .0132 | |
| 11,000 | .0139 | |
| 11,500 | .0147 | |
| 12,000 | .0155 | |
| 12,500 | .0166 | |
| 13,000 | .0180 | |
| 13,500 | .0194 | |
| 14,000 | .0214 | |
| 14,500 | .0249 | |
| 15,000 | .0322 | |
| 15,500 | .0434 | |
| 16,000 | .0594 | |
| 16,500 | .0874 | |
| 17,000 | .1274 | |
| 17,310 | .2104 | Ultimate strength = 96,910 pounds per square inch compression. |

Sheared out plate in front of hole.

## No. 481.

Distance from center of hole to end of plate, 1″.28.
End planed.
Thickness of plate, ″.250.
Compression area, .175 square inch.

| Loads applied. | Elongation of hole. | Remarks. |
|---|---|---|
| *Pounds.* | *Inch.* | |
| 1,000 | 0. | |
| 5,000 | .0048 | |
| 8,000 | .0070 | |
| 10,000 | .0090 | |
| 11,000 | .0101 | |
| 11,500 | .0110 | |
| 12,000 | .0119 | |
| 12,500 | .0128 | |
| 13,000 | .0138 | |
| 13,500 | .0148 | |
| 14,000 | .0162 | |
| 14,500 | .0180 | |
| 15,000 | .0205 | |
| 15,500 | .0241 | |
| 16,000 | .0298 | |
| 16,500 | .0380 | |
| 17,000 | .0482 | |
| 17,500 | .0600 | |
| 18,000 | .0755 | |
| 18,500 | .0930 | |
| 19,000 | .1158 | |
| 19,500 | .1440 | |
| 20,000 | .1790 | |
| 20,500 | .1980 | |
| 20,800 | .2670 | |
| 21,400 | ..... | Ultimate strength = 122,280 pounds per square inch. |

Failed by shearing out front of hole.

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No. 482.

Distance from center of hole to end of plate, 1".26.
Sheared end to plate.
Skin planed off one side of plate at the hole about ".003 deep.
Thickness of plate, ".249.
Compression area, ".246 × ".70=.172 square inch.

| Loads applied. | Elongation of hole. | Remarks. |
|---|---|---|
| *Pounds.* | *Inch.* | |
| 1,000 | 0. | |
| 5,000 | .0078 | |
| 8,000 | .0120 | |
| 10,000 | .0148 | |
| 11,000 | .0161 | |
| 11,500 | .0171 | |
| 12,000 | .0181 | |
| 12,500 | .0195 | |
| 13,000 | .0219 | |
| 13,500 | .0228 | |
| 14,000 | .0250 | |
| 14,500 | .0290 | |
| 15,000 | .0348 | |
| 15,500 | .0430 | |
| 16,000 | .0540 | |
| 16,500 | .0670 | |
| 17,000 | .0850 | |
| 17,500 | .1060 | |
| 18,000 | .1330 | |
| 19,000 | .2050 | |
| 19,780 | ..... | Ultimate strength = 115,000 pounds per square inch compression. |

Failed in the same manner as No. 480. Its strength probably impaired by the slight strip planed off at side of hole.

No. 483.

Distance from center of hole to end of plate.
Planed end of specimen.
Thickness of plate, ".250.
Compression area, .175 square inch.

| Loads applied. | Elongation of hole. | Remarks. |
|---|---|---|
| *Pounds.* | *Inch.* | |
| 1,000 | 0. | |
| 5,000 | .0035 | |
| 10,000 | .0085 | |
| 11,000 | .0098 | |
| 11,500 | .0105 | |
| 12,000 | .0115 | |
| 12,500 | .0123 | |
| 13,000 | .0135 | |
| 13,500 | .0146 | |
| 14,000 | .0157 | |
| 14,500 | .0172 | |
| 15,000 | .0187 | |
| 15,500 | .0209 | |
| 16,000 | .0237 | |
| 16,500 | .0277 | |
| 17,000 | .0322 | |
| 17,500 | .0387 | |
| 18,000 | .0465 | |
| 19,000 | .0637 | |
| 20,000 | .0857 | |
| 21,000 | .1127 | |
| 22,000 | .1487 | |
| 23,000 | .1917 | |
| 24,000 | .2577 | |
| 24,820 | .3790 | Ultimate strength = 141,830 pounds per square inch compression. |

Failed in the same manner as No. 480.

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## No. 401.

Distance from center of hole to end of plate, 1″.49.
Planed end of specimen.
Thickness of plate, 2″.53.
Compression area, .177 square inch.

| Loads applied. | Elongation of hole. | Remarks. |
|---|---|---|
| *Pounds.* | *Inch.* | |
| 1,000 | 0. | |
| 5,000 | .0033 | |
| 10,000 | .0090 | |
| 11,000 | .0101 | |
| 12,000 | .0115 | |
| 12,500 | .0121 | |
| 13,000 | .0130 | |
| 13,500 | .0140 | |
| 14,000 | .0150 | |
| 14,500 | .0160 | |
| 15,000 | .0178 | |
| 15,500 | .0192 | |
| 16,000 | .0212 | |
| 16,500 | .0240 | |
| 17,000 | .0272 | |
| 17,500 | .0315 | |
| 18,000 | .0378 | |
| 19,000 | .0540 | |
| 20,000 | .0780 | |
| 21,000 | .0990 | |
| 22,000 | .1330 | |
| 23,000 | .1780 | |
| 24,000 | .2460 | |
| 24,350 | .3110 | Ultimate strength = 137,570 pounds per square inch compression. |

Failed same as No. 480.

## No. 402.

Distance from center of hole to end of plate, 1″.75.
Planed end of plate.
Thickness of plate, ″.246.
Compression area, ″.172 square inch.

| Loads applied. | Elongation of hole. | Remarks. |
|---|---|---|
| *Pounds.* | *Inch.* | |
| 1,000 | 0. | |
| 5,000 | .0084 | |
| 10,000 | .0160 | |
| 12,000 | .0196 | |
| 12,500 | .0206 | |
| 13,000 | .0216 | |
| 13,500 | .0227 | |
| 14,000 | .0240 | |
| 14,500 | .0254 | |
| 15,000 | .0270 | |
| 15,500 | .0287 | |
| 16,000 | .0306 | |
| 16,500 | .0334 | |
| 17,000 | .0363 | |
| 17,500 | .0393 | |
| 18,000 | .0445 | |
| 18,500 | .0506 | |
| 19,000 | .0575 | |
| 19,500 | .0665 | |
| 20,000 | .0755 | |
| 21,000 | .0965 | |
| 22,000 | .1205 | |
| 23,000 | .1480 | |
| 24,000 | .1810 | |
| 25,000 | .2130 | |
| 26,000 | .2630 | |
| 26,500 | .3190 | Ultimate strength = 154,070 pounds per square inch compression. |

Failed the same as No. 480.

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No. 403.

Distance from center of hole to end of plate, 1″.76.
Plate sheared across end.
Thickness of plate, ″.249.
Compression area, ″.174 square inch.

| Loads applied. | Elongation of hole. | Remarks. |
|---|---|---|
| *Pounds.* | *Inch.* | |
| 1,000 | 0. | |
| 5,000 | .0158 | |
| 10,000 | .0195 | |
| 12,000 | .0220 | |
| 12,500 | .0228 | |
| 13,000 | .0238 | |
| 13,500 | .0249 | |
| 14,000 | .0261 | |
| 14,500 | .0280 | |
| 15,000 | .0300 | |
| 15,500 | .0325 | |
| 16,000 | .0355 | |
| 16,500 | .0410 | |
| 17,000 | .0470 | |
| 17,500 | .0582 | |
| 18,000 | .0605 | |
| 18,500 | .0690 | |
| 19,000 | .0788 | |
| 19,500 | .0900 | |
| 20,000 | .1025 | |
| 21,000 | .1295 | |
| 22,000 | .1600 | |
| 23,000 | .1930 | |
| 24,000 | .2360 | |
| 25,000 | .2820 | |
| 25,900 | .3820 | Ultimate strength = 148,850 pounds per square inch compression. |

Failed in the same manner as No. 480.

No. 404.

Thickness of plate, ″.248.
Average diameter of punched hole (″.70 + ″.78) = ″.74.
Distance from center of hole to end of plate, 2″.
The end of the specimen is planed.
Compression area, ″.174 square inch.

| Loads applied. | Elongation of hole. | Remarks. |
|---|---|---|
| *Pounds.* | *Inch.* | |
| 1,000 | 0. | |
| 5,000 | .0081 | |
| 10,000 | .0192 | |
| 12,000 | .0236 | |
| 13,000 | .0261 | |
| 13,500 | .0279 | |
| 14,000 | .0296 | |
| 14,500 | .0310 | |
| 15,000 | .0331 | |
| 15,500 | .0352 | |
| 16,000 | .0380 | |
| 16,500 | .0409 | |
| 17,000 | .0436 | |
| 17,500 | .0470 | |
| 18,000 | .0515 | |
| 18,500 | .0550 | |
| 19,000 | .0625 | |
| 19,500 | .0698 | |
| 20,000 | .0778 | |
| 20,500 | .0872 | |
| 21,000 | .0961 | |
| 22,000 | .1208 | |
| 23,000 | .1455 | |
| 24,000 | .1700 | |
| 25,000 | .2060 | |
| 28,900 | .3770 | |
| 29,200 | ..... | Ultimate strength = 167,820 pounds per square inch compression. |

Failed same as No. 480. Appearance of fracture silky.

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No. 405.

Thickness of plate, ″.248.
Diameter of punched holes: Punch side, ″.77; die side, ″.81; average diameter, ″.79.
Same pin used as before, ″.70 diameter.
Distance from center of hole to end of plate, 2″.05.
Plate planed across end.
Compression area, .174 square inch.

| Loads applied. | Elongation of hole. | Remarks. |
|---|---|---|
| *Pounds.* | *Inch.* | |
| 1,000 | 0. | |
| 5,000 | .0095 | |
| 10,000 | .0240 | |
| 12,000 | .0320 | |
| 14,000 | .0420 | |
| 15,000 | .0480 | |
| 15,500 | .0515 | |
| 16,000 | .0549 | |
| 16,500 | .0590 | |
| 17,000 | .0620 | |
| 17,500 | .0662 | |
| 18,000 | .0710 | |
| 18,500 | .0756 | |
| 19,000 | .0812 | |
| 19,500 | .0889 | |
| 20,000 | .0962 | |
| 21,000 | .1140 | |
| 22,000 | .1340 | |
| 23,000 | .1618 | |
| 24,000 | .1895 | |
| 25,000 | .2228 | |
| 30,980 | ..... | Ultimate strength=178,050 pounds per square inch compression. |

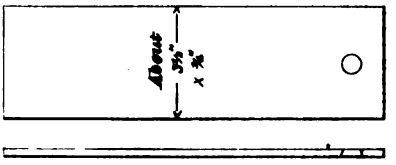
Failed the same as No. 480.

*Details of riveted joints.*

¼″ STEEL PLATE—PUNCHED HOLES.

Resistance of plates to tearing out punched holes; ⅝″ punched holes plates not riveted.
Holes varying from 1″ to 2″ from end of plates.

FORM OF SPECIMENS.




Holes punched: Punch side, ″.64 diameter; die side, ″.70 diameter.
Pin used in punched holes, ⅝″ diameter.
Sheared ends.

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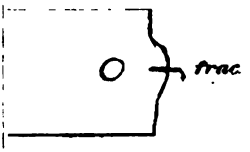
| Number of test. | Distance from center of hole to end of plate. | Thickness of plate. | Compression area. Diameter of pin × thickness of plate. | Ultimate resistance. Actual pounds. | Ultimate resistance. Pounds per square inch on compression area. | Remarks. |
|---|---|---|---|---|---|---|
| | *Inches.* | *Inch.* | *Sq. in.* | | | |
| 406 | 1.00 | .246 | .154 | 15,770 | 102,400 |  |
| 407 | 1.04 | .248 | .155 | 16,990 | 109,600 | |
| 408 | 1.27 | .245 | .153 | 19,780 | 129,300 | |
| 409 | 1.27 | .245 | .153 | 20,270 | 132,500 | Fractures all began at sheared ends, as shown above. |
| 410 | 1.50 | .246 | .154 | 21,900 | 142,200 | |
| 411 | 1.50 | .247 | .154 | 23,210 | 150,700 | |
| 412 | 1.74 | .246 | .154 | 25,390 | 164,900 | |
| 413 | 1.72 | .247 | .154 | 25,490 | 165,500 | |
| 414 | 2.00 | .248 | .152 | 27,830 | 183,100 | |
| 415 | 1.99 | .245 | .153 | 29,300 | 191,500 | |

Above specimens, Nos. 406 to 415, inclusive, prepared with $\frac{11}{16}$″ drilled holes through opposite ends.

Same $\frac{5}{8}$″ pin used as before.

## $\frac{1}{4}$″ Steel Plate, $\frac{11}{16}$″ Drilled Holes.

SHEARED ENDS.

| Number of test. | Distance from center of hole to end of plate. | Thickness of plate. | Compression area. Diameter of pin × thickness of plate. | Ultimate resistance. Actual pounds. | Ultimate resistance. Pounds per square inch on compression area. | Remarks. |
|---|---|---|---|---|---|---|
| | *Inches.* | *Inch.* | *Sq. in.* | | | |
| 416 | 1.00 | .252 | .158 | 15,800 | 100,000 | Fractures all began at sheared end, except No. 424, which began at the holes. |
| 417 | 1.00 | .246 | .154 | 16,100 | 104,500 | |
| 418 | 1.25 | .247 | .154 | 19,430 | 126,200 | |
| 419 | 1.25 | .244 | .153 | 18,970 | 124,000 | |
| 420 | 1.50 | .246 | .154 | 21,850 | 141,900 | |
| 421 | 1.50 | .244 | .153 | 21,550 | 140,850 | |
| 422 | 1.77 | .245 | .153 | 23,900 | 156,200 | |
| 423 | 1.78 | .250 | .156 | 27,890 | 178,800 | |
| 424 | 2.02 | .246 | .154 | 28,470 | 184,900 | |
| 425 | 2.03 | .245 | .153 | 28,800 | 188,200 | |

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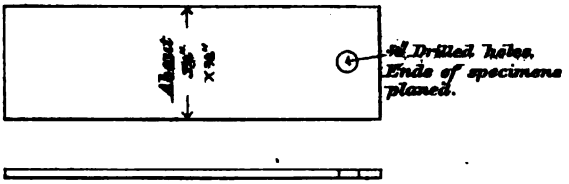
## WROUGHT-IRON PLATE.

(Tests to determine the ultimate resistance of iron plate to tearing out at the rivet holes.)

### $\frac{5}{8}$" DRILLED HOLES.

SHAPE OF SPECIMENS.




### No. 445.

Thickness of plate, ".241.
From center of hole to end of plate, ".99.
Compression area of hole ".625 × ".241 = .151 square inch.

| Loads applied. | Elongation of hole. | Permanent elongation of hole. | Remarks. |
|---|---|---|---|
| *Pounds.* | *Inch.* | *Inch.* | |
| 1,000 | ..... | ..... | |
| 5,000 | .0065 | ..... | |
| 1,000 | ..... | .0035 | |
| 6,000 | .0088 | ..... | |
| 7,000 | .0115 | ..... | |
| 8,000 | .0155 | ..... | |
| 9,000 | .0246 | ..... | |
| 9,500 | .0308 | ..... | |
| 10,000 | .0398 | ..... | |
| 10,250 | About .09 | ..... | Ultimate strength = 67,880 pounds per square inch on compression area of holes. |

Failed by developing a fracture at end of plate, where metal was under tensile strain. Fracture then extended towards drilled hole.

### No. 446.

Duplicate of No. 445.
Thickness of plate, ".244.
Distance from center of hole to end of plate, 1".
Compression area of hole, ".625 × ".244 = .153 square inch.

| Loads applied. | Elongation of hole. | Permanent elongation of holes. | Remarks. |
|---|---|---|---|
| *Pounds.* | *Inch.* | *Inch.* | |
| 1,000 | 0. | ..... | |
| 5,000 | .0060 | ..... | |
| 1,000 | ..... | .0028 | |
| 6,000 | .0071 | ..... | |
| 6,500 | .0080 | ..... | |
| 7,000 | .0090 | ..... | |
| 7,500 | .0100 | ..... | |
| 8,000 | .0118 | ..... | |
| 8,500 | .0140 | ..... | |
| 9,000 | .0176 | ..... | |
| 9,500 | .0220 | ..... | |
| 10,000 | .0285 | ..... | |
| 10,500 | .0345 | ..... | |
| 11,000 | .0480 | ..... | |
| 11,280 | .0630 | ..... | Ultimate strength = 73,720 pounds per square inch on compression area. |

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Test continued after passing the ultimate resistance, developing fractures on either side of the hole.

The initial fracture began at the end of the plate, reaching back to the hole.

No. 447.

Compression area, ″.625 × ″.245 = .153 square inch.
Thickness of plate, ″.245.
Distance from center of ⅝″ hole to end of plate, 1″.25.

| Loads applied. | Elongation of hole. | Remarks. |
|---|---|---|
| *Pounds.* | *Inch.* | |
| 1,000 | ..... | |
| 2,000 | .0020 | |
| 3,000 | .0036 | |
| 4,000 | .0055 | |
| 5,000 | .0071 | |
| 6,000 | .0086 | |
| 6,500 | .0096 | |
| 7,000 | .0106 | |
| 7,500 | .0118 | |
| 8,000 | .0135 | |
| 8,500 | .0150 | |
| 9,000 | .0168 | |
| 9,500 | .0189 | |
| 10,000 | .0215 | |
| 10,500 | .0244 | |
| 11,000 | .0296 | |
| 11,500 | .0355 | |
| 12,000 | .0430 | |
| 12,500 | .0535 | |
| 12,720 | .0705 | Ultimate strength = 83,140 pounds per square inch on compression area. |

Failed same as specimen No. 445..

No. 448.

Duplicate of No. 447.
Thickness of plate, ″.243.
Distance from center of hole to end of plate, 1″.22.
Compression area, ″.625 × ″.243 = .152 square inch.

| Loads applied. | Elongation of hole. | Remarks. |
|---|---|---|
| *Pounds.* | *Inch.* | |
| 1,000 | 0. | |
| 5,000 | .0070 | |
| 6,000 | .0090 | |
| 6,500 | .0100 | |
| 7,000 | .0109 | |
| 7,500 | .0118 | |
| 8,000 | .0128 | |
| 8,500 | .0142 | |
| 9,000 | .0161 | |
| 9,500 | .0182 | |
| 10,000 | .0210 | |
| 10,500 | .0245 | |
| 11,000 | .0290 | |
| 11,500 | .0342 | |
| 12,000 | .0410 | |
| 12,500 | .0500 | |
| 13,000 | .0810<br>.0880 | Ultimate strength = 85,530 pounds per square inch on compression area. |

Failed same as No. 445.

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No. 449.

Thickness of plate, ″.243.
Distance from center of hole to end of plate, 1″.50.
Compression area, ″.625 × ″.243 = .152 square inch.

| Loads applied. | Elongation of hole. | Remarks. |
|---|---|---|
| *Pounds.* | *Inch.* | |
| 1,000 | ..... | |
| 5,000 | .0042 | |
| 6,000 | .0053 | |
| 6,500 | .0063 | |
| 7,000 | .0073 | |
| 7,500 | .0083 | |
| 8,000 | .0093 | |
| 8,500 | .0107 | |
| 9,000 | .0123 | |
| 9,500 | .0142 | |
| 10,000 | .0163 | |
| 10,500 | .0187 | |
| 11,000 | .0217 | |
| 11,500 | .0247 | |
| 12,000 | .0287 | |
| 12,500 | .0332 | |
| 13,000 | .0392 | |
| 13,500 | .0460 | |
| 14,000 | .0537 | |
| 15,510 | .0992 | Ultimate strength = 102,040 pounds per square inch on compression. |

Failed same as No. 445.

No. 450.

Duplicate of No. 449.
Thickness of plate, ″.243.
Distance from center of hole to end of plate, 1″.50.
Compression area, .152 square inch.

| Loads applied. | Elongation of hole. | Remarks. |
|---|---|---|
| *Pounds.* | *Inch.* | |
| 1,000 | 0. | |
| 5,000 | .0049 | |
| 6,000 | .0060 | |
| 7,000 | .0078 | |
| 7,500 | .0089 | |
| 8,000 | .0100 | |
| 8,500 | .0112 | |
| 9,000 | .0130 | |
| 9,500 | .0151 | |
| 10,000 | .0175 | |
| 10,500 | .0208 | |
| 11,000 | .0239 | |
| 11,500 | .0275 | |
| 12,000 | .0321 | |
| 12,500 | .0380 | |
| 13,000 | .0450 | |
| 13,500 | .0520 | |
| 14,000 | .0610 | |
| 15,000 | .0810 | |
| 15,780 | .1180 | Ultimate strength = 103,820 pounds per square inch compression. |

Fractured same as No. 445.

$\frac{1}{4}$″ plates Nos. 445 to 450, inclusive, that have been tested with drilled holes, now prepared with punched holes through opposite ends, punched and riveted together in pairs with $\frac{5}{8}$″ iron rivets. The rivet heads were planed off and the rivets driven out.



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It is found that these machine-driven rivets produce serious injury to the plates. When the hole was within $1\frac{1}{4}''$ of the edge the plates were burst by the rivets, starting fractures at the edge of the plate.

While the plates in this condition, with fracture already developed, will fail to give the comparative strength of drilled and punched holes, the results will probably give an indication of the strength of riveted joints in iron plates that have been weakened in this same manner.

Specimens Nos. 451 to 456, inclusive, have punched holes. Size of punch, $\frac{11}{16}''$ diameter; die, $\frac{3}{4}''$ diameter.

Diameter of pin used in punched holes, ".70.

No. 451.

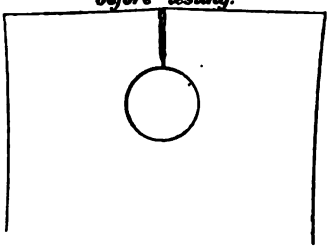
Thickness of plate, ".241.

Distance from center of hole to end of plate, 1".

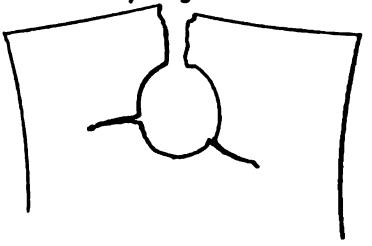
Compression area ".241 × ".70 = .1687 square inch.

| Loads applied. | Elongation of hole. | Remarks. |
|---|---|---|
| *Pounds.* | *Inch.* | |
| 1,000 | 0. | |
| 5,000 | .0215 | |
| 6,000 | .0275 | |
| 7,000 | .0338 | |
| 8,000 | .0410 | |
| 8,250 | ..... | Ultimate strength = 48,900 pounds per square inch compression. |

*Sketch of specimen before testing.*



*Showing fractures developed by test.*



No. 452.

Thickness of plate, ".244.

Distance from center of whole to end of plate, 1".

Compression area ".244 × ".70 = .171 square inch.

8,100 pounds ultimate strength = 47,370 pounds per square inch compression.

Fracture started same as in No. 451.

Afterwards developed fractures at sides of hole.

No. 453.

Thickness of plate, ".245.

Distance from center of hole to end of plate, 1".25.

Compression area, ".245 × ".70 = .172 square inch.

11,200 pounds ultimate strength = 65,120 pounds per square inch compression.

Fracture at end of plate about 4" long, reaching back towards hole.

End of specimen sheared.

Failed by opening initial fracture and a fracture at side of hole.

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No. 454.

Thickness of plate, ″.243.
Distance from center of hole to end of plate, 1″.20.
Compression area, ″.243 × ″.70 = .17 square inch.
Fracture in end of plate caused by riveting similar to No. 453.
12,500 pounds ultimate strength = 73,530 pounds per square inch compression.

No. 455.

Thickness of plate, ″.243.
Distance from center of hole to end of plate, 1″.47.
Compression area, ″.243 × ″.70 = .170 square inch.
Punched hole about ″.02 larger in diameter than the punch and die used.
No fracture in sight caused by riveting.
End of plate sheared.

| Loads applied. | Elongation of hole. | Remarks. |
|---|---|---|
| *Pounds.* | *Inch.* | |
| 1,000 | 0. | |
| 5,000 | .0062 | |
| 10,000 | .0206 | |
| 10,500 | .0215 | |
| 11,000 | .0230 | |
| 11,500 | .0248 | |
| 12,000 | .0268 | |
| 12,500 | .0289 | |
| 13,000 | .0310 | |
| 13,500 | .0339 | |
| 14,000 | .0380 | |
| 14,500 | .0439 | |
| 15,000 | .0530 | |
| 15,150 | .0570 | Ultimate strength = 89,120 pounds per square inch compression. |

Fracture began at end of plate.

No. 456.

Thickness of plate, ″.243.
Distance from center of hole to end of plate, 1″.47.
End of plate planed.
Compression area, ″.243 × ″.70 = .170 square inch.

| Loads applied. | Elongation of hole. | Remarks. |
|---|---|---|
| *Pounds.* | *Inch.* | |
| 1,000 | 0. | |
| 5,000 | .0070 | |
| 8,000 | .0139 | |
| 10,000 | .0188 | |
| 10,500 | .0201 | |
| 11,000 | .0218 | |
| 11,500 | .0235 | |
| 12,000 | .0255 | |
| 12,500 | .0280 | |
| 13,000 | .0305 | |
| 13,500 | .0335 | |
| 14,000 | .0372 | |
| 14,500 | .0410 | |
| 15,000 | .0460 | |
| 15,500 | .0515 | |
| 16,000 | .0605 | |
| 16,300 | .0750 | Ultimate strength = 95,900 pounds per square inch compression. |

Failed by opening a fracture at the end of the plate.

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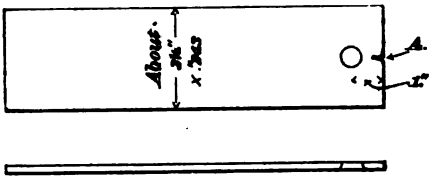
Nos. 457 to 462, inclusive.

¼″ plates having ⅝″ punched holes. Punch, ″.64 diameter; die, ″.71 diameter.

Plates did not have rivets driven. Ends planed.

Diameter of pin used in punched holes, ⅝″.

No. 457.




Compression area, ″.243×″.625=.152 square inch.

| Loads applied. | Elongation of hole. | Remarks. |
|---|---|---|
| *Pounds.* | *Inch.* | |
| 1,000 | 0. | |
| 3,000 | .0090 | |
| 5,000 | .0182 | |
| 5,500 | .0205 | |
| 6,000 | .0230 | |
| 6,500 | .0251 | |
| 7,000 | .0285 | |
| 7,500 | .0318 | |
| 8,000 | .0358 | |
| 8,500 | .0405 | |
| 9,000 | .0450 | |
| 9,000 | .0468 | After twelve minutes rest. |
| 9,500 | .0528 | |
| 10,000 | .0608 | |
| 10,500 | .0718 | |
| 11,000 | .1000 | Ultimate strength=72,370 pounds per square inch compression. |

Fracture began at end of plate at *A*.

No. 458.

Duplicate of No. 457.

Distance from center of hole to end of plate, 1″.

Compression area, ″.241×″.625=.151 square inch.

| Loads applied. | Elongation of hole. | Remarks. |
|---|---|---|
| *Pounds.* | *Inch.* | |
| 1,000 | 0. | |
| 5,000 | .0211 | |
| 5,500 | .0232 | |
| 6,000 | .0260 | |
| 6,500 | .0288 | |
| 7,000 | .0310 | |
| 7,500 | .0340 | |
| 8,000 | .0370 | |
| 8,500 | .0408 | |
| 9,000 | .0440 | |
| 9,500 | .0490 | |
| 10,000 | .0558 | |
| 10,500 | .0620 | |
| 11,000 | .0720 | |
| 11,500 | .0840 | |
| 11,860 | .0990 | Ultimate strength=78,540 pounds per square inch compression. |

Fracture began at end of plate same as No. 457.

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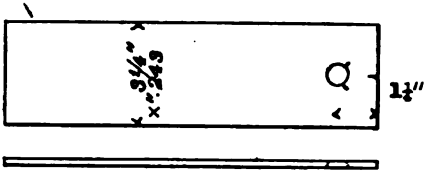
No. 459.




Compression area, ".243×".625=.152 square inch.

| Loads applied. | Elongation of hole. | Remarks. |
|---|---|---|
| *Pounds.* | *Inch.* | |
| 1,000 | 0. | |
| 5,000 | .0065 | |
| 5,500 | .0102 | |
| 6,000 | .0121 | |
| 6,500 | .0140 | |
| 7,000 | .0161 | |
| 7,500 | .0185 | |
| 8,000 | .0210 | |
| 8,500 | .0235 | |
| 9,000 | .0260 | |
| 9,500 | .0300 | |
| 10,000 | .0340 | |
| 10,500 | .0395 | |
| 11,000 | .0461 | |
| 11,500 | .0530 | |
| 12,000 | .0625 | |
| 12,500 | .0728 | |
| 13,000 | .0850 | |
| 13,440 | .1040 | Ultimate strength = 88,420 pounds per square inch compression. |

Fracture began at end of plate and at sides of hole.

No. 460.

Duplicate of No. 459.
Thickness of plate, ".243.
Compression area, ".243×".625=.152 square inch.

| Loads applied. | Elongation of hole. | Remarks. |
|---|---|---|
| *Pounds.* | *Inch.* | |
| 1,000 | 0. | |
| 5,000 | .0095 | |
| 6,000 | .0140 | |
| 7,000 | .0185 | |
| 7,500 | .0208 | |
| 8,000 | .0230 | |
| 8,500 | .0259 | |
| 9,000 | .0288 | |
| 9,500 | .0320 | |
| 10,000 | .0375 | |
| 10,500 | .0420 | |
| 11,000 | .0490 | |
| 11,500 | .0570 | |
| 12,000 | .0653 | |
| 12,500 | .0748 | |
| 13,000 | .0888 | Ultimate strength = 85,520 pounds per square inch compression. |

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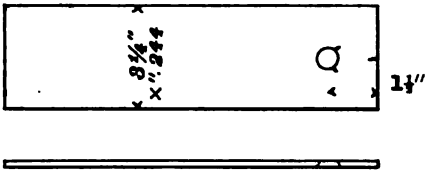
No. 461.



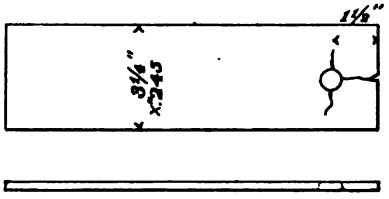

Compression area, ".244×".625=.153 square inch.

| Loads applied. | Elongation of hole. | Remarks. |
|---|---|---|
| *Pounds.* | *Inch.* | |
| 1,000 | 0. | |
| 5,000 | .0110 | |
| 6,000 | .0142 | |
| 7,000 | .0170 | |
| 8,000 | .0208 | |
| 8,500 | .0230 | |
| 9,000 | .0252 | |
| 9,500 | .0280 | |
| 10,000 | .0310 | |
| 10,500 | .0340 | |
| 11,000 | .0380 | |
| 11,500 | .0410 | |
| 12,000 | .0470 | |
| 12,500 | .0515 | |
| 13,000 | .0575 | |
| 13,500 | .0640 | |
| 15,500 | ..... | Ultimate strength = 101,310 pounds per square inch compression. |

Test discontinued soon as maximum load was passed.
Fractures started at edge of plate, also at sides of punched hole.

No. 462.

Duplicate of No. 461.




Compression area ".245×".625=.153 square inch.

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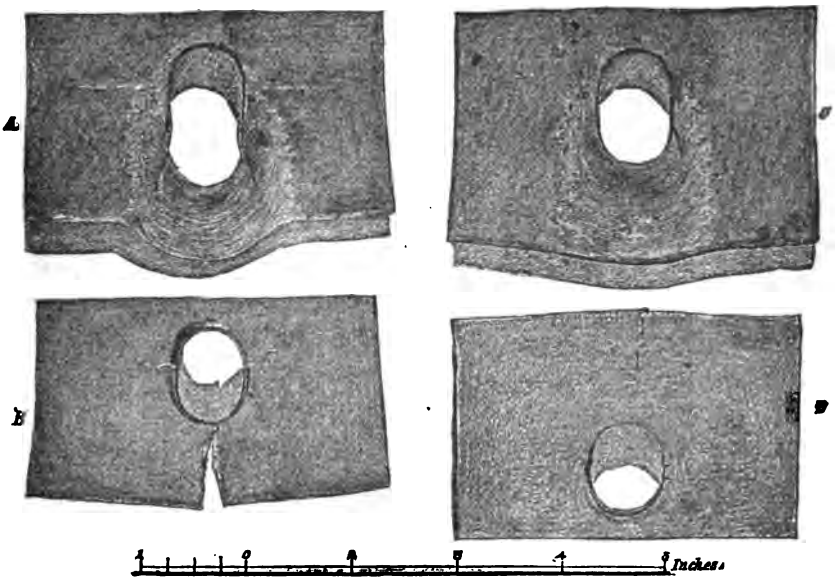
| Loads applied. | Elongation of hole. | Remarks. |
|---|---|---|
| *Pounds.* | *Inch.* | |
| 1,000 | 0. | |
| 5,000 | .0175 | |
| 6,000 | .0208 | |
| 7,000 | .0250 | |
| 8,000 | .0295 | |
| 8,500 | .0318 | |
| 9,000 | .0340 | |
| 9,500 | .0368 | |
| 10,000 | .0390 | |
| 10,500 | .0428 | |
| 11,000 | .0485 | |
| 11,500 | .0502 | |
| 12,000 | .0550 | |
| 12,500 | .0605 | |
| 13,000 | .0670 | |
| 13,500 | .0742 | |
| 14,000 | .0830 | |
| 14,500 | .0938 | |
| 15,000 | .1070 | |
| 15,500 | .1260 | |
| 15,745 | .1490 | Ultimate strength = 102,910 pounds per square inch compression. |

Fractures developed as shown by sketch.

*Resistance of steel and iron plates to tearing out at rivet holes.*

$\frac{1}{2}$″ STEEL PLATE, PLANED ENDS.




$\frac{1}{2}$″ IRON PLATE, PLANED ENDS.

Fractures in plates having $\frac{11}{16}$″ punched holes.
$1\frac{1}{4}$″ from center of hole to end of Plates *A* and *B*.
$1\frac{1}{2}$″ from center of hole to end of Plates *C* and *D*.

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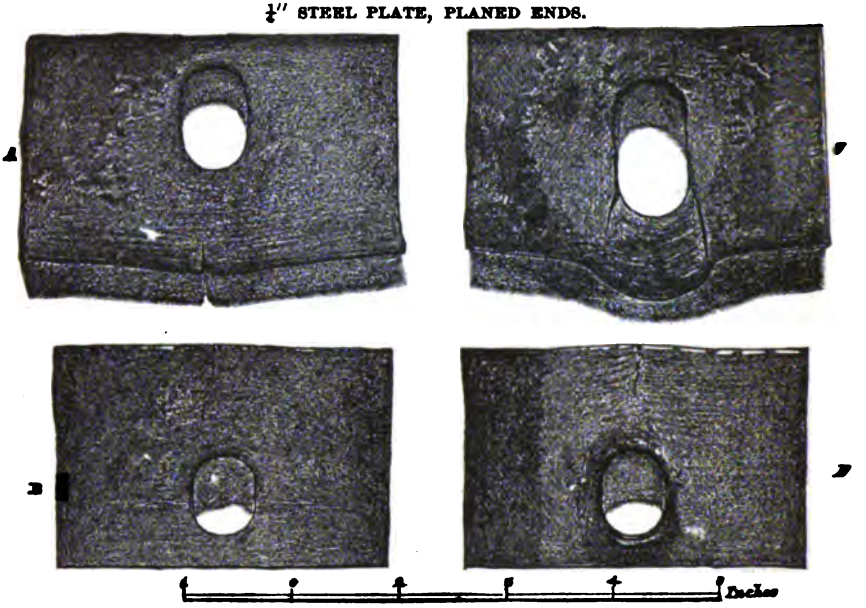
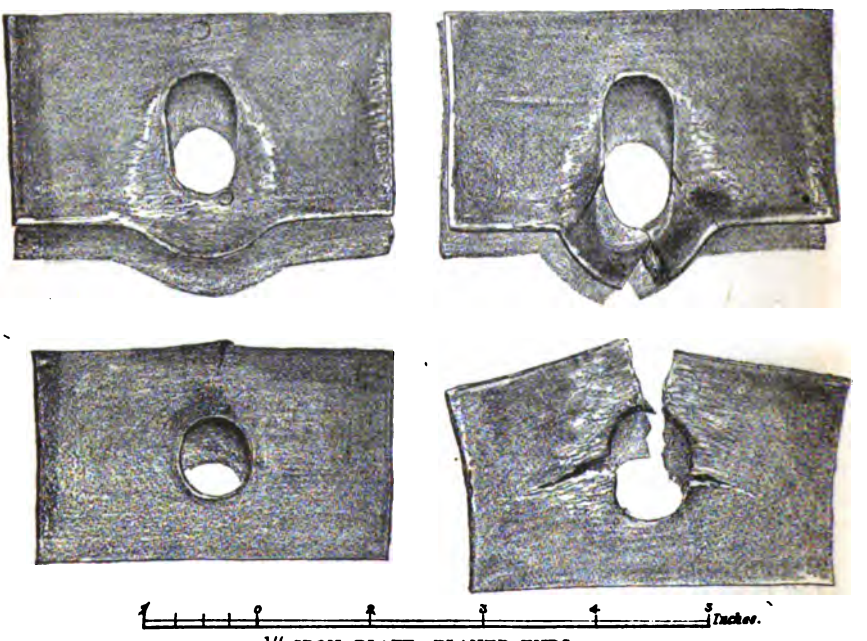
½″ STEEL PLATE, PLANED ENDS.




½″ IRON PLATE, PLANED ENDS.

Fractures in plates having $1\frac{1}{16}$″ punched holes.
$1\frac{1}{8}$″ from center of hole to end of Plates *A* and *B*.
$1\frac{1}{4}$″ from center of hole to end of Plates *C* and *D*.

½′ STEEL PLATE, PLANED ENDS.




½″ IRON PLATE, PLANED ENDS.

Fractures in plates having $\frac{5}{8}$″ drilled holes.
1″ from center of hole to end of plate.

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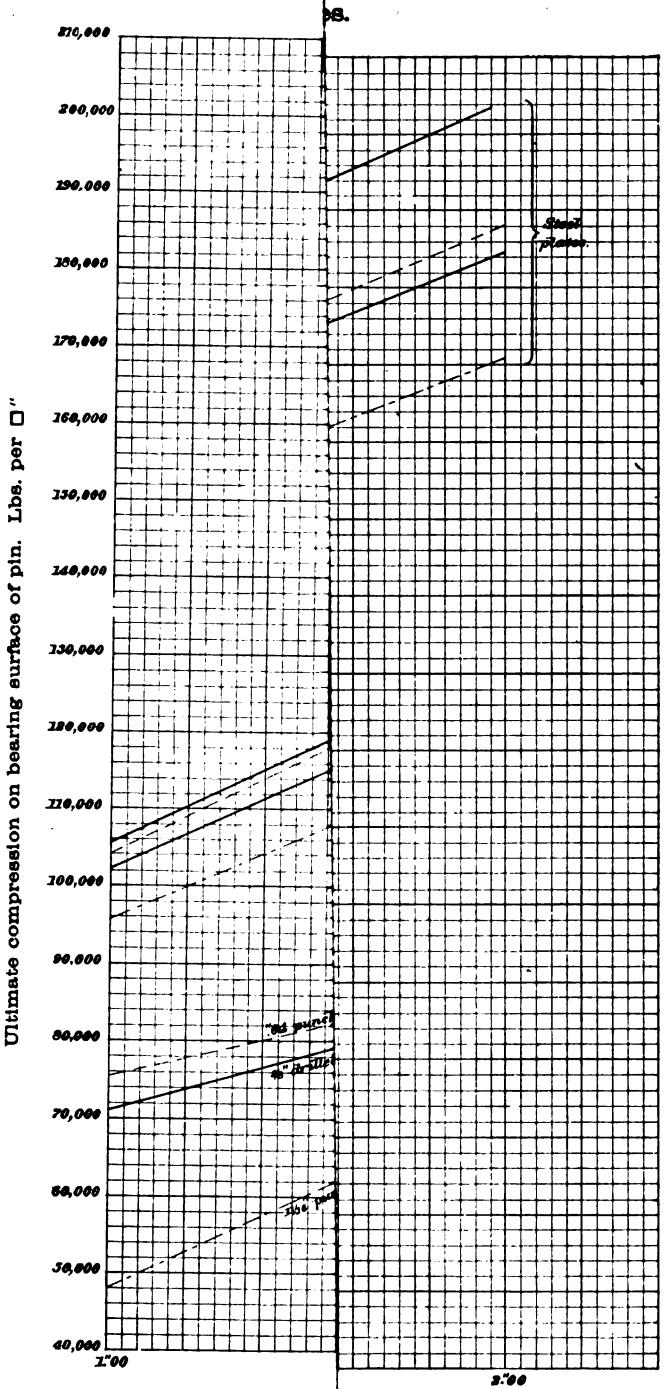


Drilled ho
Punched
Punched

S. Ex. 1——face p. 1

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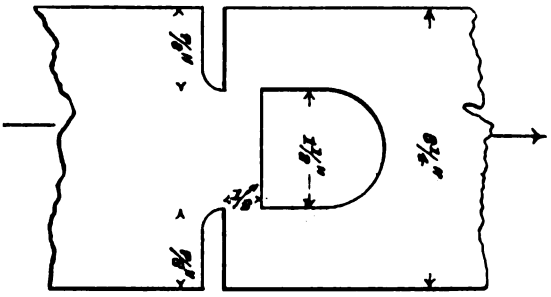
## ¼″ Wrought-iron Plate.

(Shearing parallel to grain.)

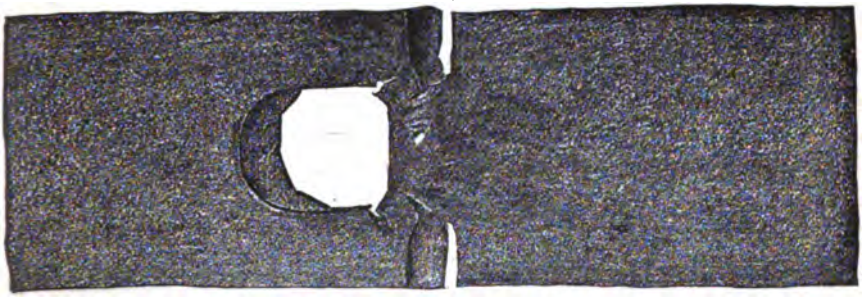
### No. 300.

FORM OF SPECIMEN.




**Shearing area, ″.5×″.276×2 = .276 square inch.**
**Ultimate strength, 7,728 pounds = 28,800 pounds per square inch.**

SPECIMEN AFTER FRACTURE.

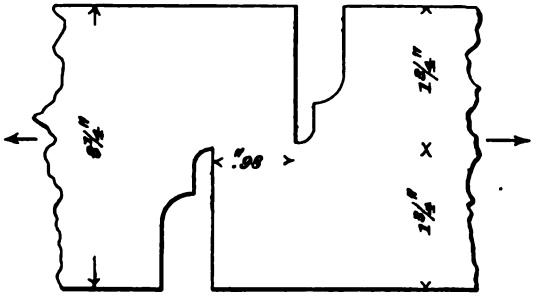


### No. 301.

**Same form as No. 300.**
**Shearing area, ″.50×″.278×2 = .278 square inch.**
**Ultimate strength, 7,850 pounds = 28,240 pounds per square inch.**
**Failed same manner as No. 300.**

### No. 302.

FORM OF SPECIMEN.

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SPECIMEN AFTER FRACTURE.

Shearing area, ″.98×″.279 = .273 square inch.
Ultimate strength, 6,900 pounds = 25,270 pounds per square inch.

No. 303.

Same form as No. 302.
Shearing area, ″.98×″.276 = .270 square inch.
Ultimate strength, 6,980 pounds = 25,290 pounds per square inch.
Failed in the same manner as No. 302.

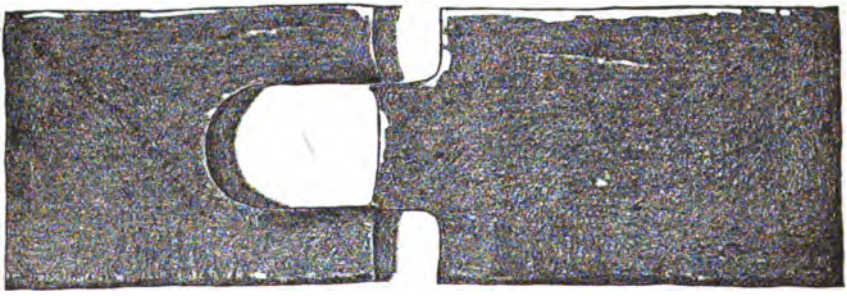
¼″ STEEL PLATE.

(Shearing parallel to direction of rolling.)

No. 318.

Original form of specimen same as No. 300.

SPECIMEN AFTER FRACTURE.



Shearing area, ″.50×″.245× 2 = .245 square inch.
Ultimate strength, 9,450 pounds = 38,570 pounds per square inch.

No. 319.

¼″ steel, same form as No. 318.
Shearing area, ″.50×″.249×2 = .249 square inch.
Ultimate strength, 10,120 pounds = 40,640 pounds per square inch.
Tore out evenly at each shearing line.

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No. 320.

⅛″ STEEL PLATE.

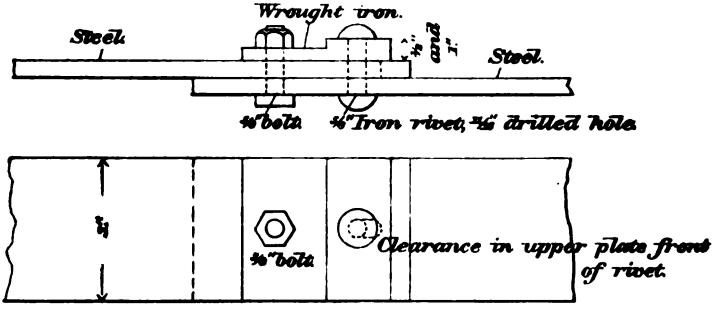
Original form of specimen same as No. 302.

SPECIMEN AFTER FRACTURE.

Shearing area, 1″ × ″.255 = .255 square inch.
Ultimate strength, 9,200 pounds = 36,080 pounds per square inch.
Failed by shearing from bottom of groove to bottom of groove, one line of shearing.

DETAILS OF RIVETED JOINTS—FRICTION OF RIVETS.

*Experiments to determine the force necessary to slip a joint or plates held together by the friction of the rivet only.*




Gauge measures elongations in 10″ section, including the joint. The ⅝″ bolt used to hold washer in place while riveting removed before the test.

No. 463.

Thickness of steel plates, ″.31 each; width, about 3″.
Thickness of washer ″.50.
Length of rivet under heads, 1″.12.

| Loads applied. | Elongation. | Remarks. |
|---|---|---|
| *Pounds.* | *Inch.* | |
| 1,000 | 0. | |
| 2,000 | .0003 | |
| 3,000 | .0008 | |
| 4,000 | .0013 | |
| 5,000 | .0020 | Slipping began at 5,400 pounds. |
| 5,500 | .0092 | |

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No. 463.

Maximum resistance, 5,980 pounds a load, which was reached and held momentarily.

It seems quite probable that the available resistance offered by the friction of the rivet was 5,400 pounds.

The joint was found oily after shearing the rivet.

Rivet sheared between steel plates at about 14,000 pounds.

No. 464.

Thickness of steel plates, ".30 each.

Thickness of washer, ".50.

Total length of rivet under heads, 1".10.

Shearing area of rivet, .371 square inch.

| Loads applied. | Elongation. | Remarks. |
|---|---|---|
| *Pounds.* | *Inch.* | |
| 1,000 | 0. | |
| 2,000 | .0005 | |
| 3,000 | .0008 | |
| 4,000 | .0016 | |
| 5,000 | .0019 | |
| 5,500 | .0024 | |
| 5,950 | .0098 | Rapid slipping. |
| 64,000 | ..... | Maximum load reached. |
| 15,650 | ..... | Shearing strength of rivet=42,180 pounds per square inch. |

Joint oily. Sheared the rivet between steel plates and started off rivet head slightly. Hole in lower steel plate elongated about ".01.

No. 465.

Thickness of steel plates, ".30, ".28; thickness of washer, 1".

Length of rivet under heads, 1".58.

| Loads applied. | Elongation. | Remarks. |
|---|---|---|
| *Pounds.* | *Inch.* | |
| 1,000 | 0. | |
| 2,000 | .0002 | |
| 3,000 | .0007 | |
| 4,000 | .0011 | |
| 4,800 | .0012 | |
| | .0034 | Sudden slip. This load considered the limit of friction between the plates. Unaffected by cutting of the surface in contact. |
| 5,000 | .0052 | |
| 5,500 | .0083 | |
| 6,000 | .0100 | |
| 6,500 | .0112 | |
| 7,000 | .0128 | |
| 7,480 | .0162 | Rapid slipping takes place. |
| 8,000 | .0661 | |
| 8,500 | .1112 | |
| 9,000 | .1522 | |
| 10,000 | .2032 | |
| 11,000 | .2134 | |
| 12,000 | .2282 | |
| 13,000 | .2472 | |
| 15,900 | ..... | Ultimate strength of rivet=42,830 pounds per square inch. |

The peculiar behavior of the above specimen thought to be due to a burr on the upper plate cutting the under plate, which would increase the resistance after first slipping took place.

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No. 466.

Thickness of steel plate, ".30 each; thickness of washer, 1". Length of rivet, 1".60.

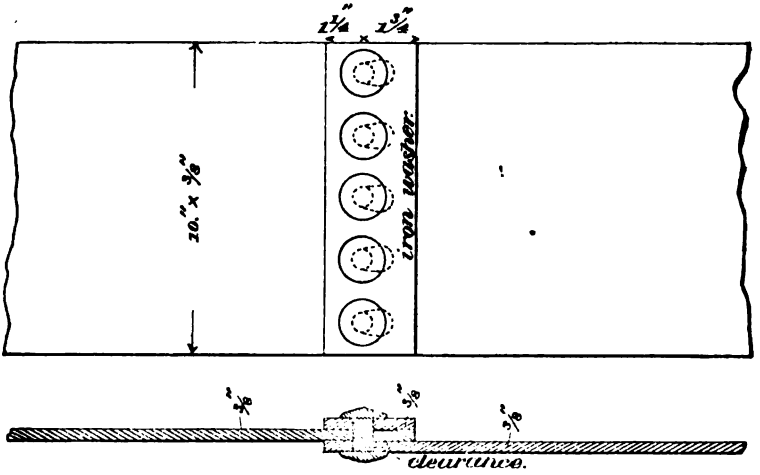
| Loads applied. | Elongation. | Remarks. |
|---|---|---|
| *Pounds.* | *Inch.* | |
| 1,000 | 0. | |
| 2,000 | .0002 | |
| 3,000 | .0006 | |
| 4,000 | .0016 | |
| 5,000 | .0033 | |
| 5,500 | .0058 | This load considered sufficient to overcome the friction caused by the rivet when unaffected by the cutting of the surfaces in contact. |
| 6,000 | .0115 | |
| 7,000 | .0310 | |
| 8,000 | .0610 | |
| 8,500 | .1690 | |
| 8,900 | ..... | Maximum resistance due to friction of rivet. |
| 12,300 | ..... | Ultimate shearing strength of rivet = 27,180 pounds per square inch. |

Plates cut same as in experiment No. 465.

*Friction of rivets.*

No. 248.

⅜" IRON PLATE.




Five $\frac{11}{16}$" iron rivets.
Five ¾" drilled holes, with clearance front of rivets in upper plate.
This specimen made up of plates in test F . . clamped with 20" exposure between holder faces; corners of holes rounded about ".05.
Shearing area of five rivets (¾" diameter), 2.21 square inches.

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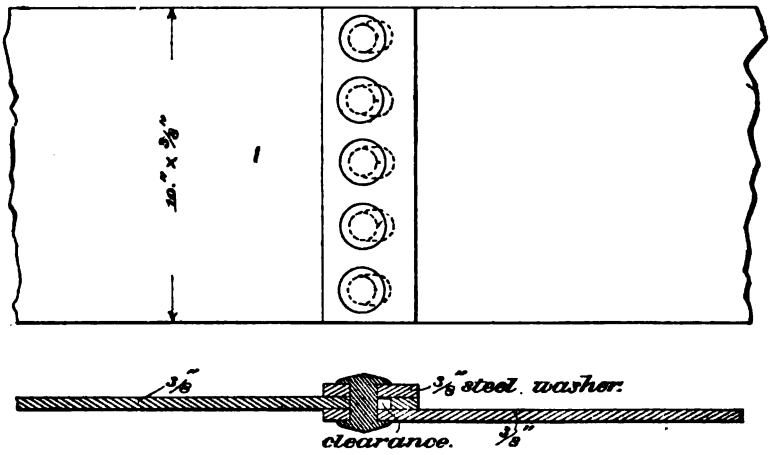
| Loads applied. | Elongation in 10 inches. | Permanent set. | Remarks. |
|---|---|---|---|
| *Pounds.* | *Inch.* | *Inch.* | |
| 5,000 | 0. | ..... | |
| 10,000 | .0008 | ..... | |
| 15,000 | .0018 | ..... | |
| 20,000 | .0030 | ..... | |
| 25,000 | .0050 | ..... | |
| 27,000 | .0068 | ..... | |
| 28,000 | .0075 | ..... | |
| 29,000 | .0090 | ..... | |
| 30,000 | .0108 | ..... | |
| 5,000 | ..... | .0058 | |
| 31,000 | .0130 | ..... | Rapid slipping began when load passed 31,000 pounds. The resistance to slipping continued about 30,000 pounds, till total slip was ".15. |
| 32,000 | .15 | ..... | |
| 35,000 | .18 | ..... | Friction per rivet, $\frac{31000}{5}$ = 6,200 pounds. |
| 40,000 | .26 | ..... | |
| 45,000 | .32 | ..... | |
| 50,000 | .35 | ..... | |
| 55,000 | .36 | ..... | |
| 60,000 | .38 | ..... | |
| 65,000 | .40 | ..... | |
| 70,000 | .41 | ..... | |
| 75,000 | .45 | ..... | |
| 80,000 | .47 | ..... | Shearing strength of rivets, 41,630 pounds per square inch. |
| 85,000 | .54 | ..... | |
| 90,000 | .65 | ..... | |
| 92,000 | ..... | ..... | Ultimate strength. Sheared rivets. |

Under plate cut vicinity of rivet holes by upper plate slipping over it.

$\frac{3}{8}$" STEEL PLATE.




Five $\frac{11}{16}$" iron rivets; $\frac{3}{4}$" drilled holes.
Clearance given rivets in upper plates.
Corners of rivet holes rounded about ".05.
Shearing area five rivets ($\frac{3}{4}$" diameter), 2.21 square inches.

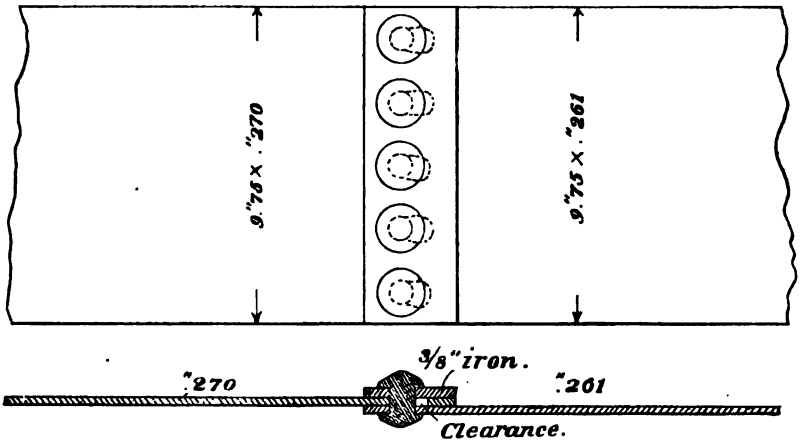
Digitized by Google

| Loads applied. | Elongation in 10 inches. | Remarks. |
|---|---|---|
| *Pounds.* | *Inch.* | |
| 5,000 | 0. | |
| 10,000 | .0010 | |
| 12,000 | .0115 | |
| 14,000 | .0020 | |
| 16,000 | .0022 | |
| 18,000 | .0028 | |
| 20,000 | .0030 | |
| 22,000 | .0035 | |
| 24,000 | .0041 | |
| 26,000 | .0048 | |
| 28,000 | .0065 | |
| 30,000 | .0100 | |
| 31,000 | .0121 | Slipping continued, the resistance falling to 28,000 pounds. |
| 31,000 | .180 | |
| 32,000 | .185 | |
| 33,000 | .19 | Friction per rivet, $\frac{31000}{5}$ = 6,200 pounds. |
| 34,000 | .22 | |
| 35,000 | .23 | |
| 40,000 | .32 | |
| 45,000 | .36 | |
| 50,000 | .375 | |
| 55,000 | .385 | |
| 60,000 | .40 | |
| 65,000 | .425 | |
| 70,000 | .445 | |
| 75,000 | .47 | |
| 80,000 | .49 | |
| 85,000 | .54 | |
| 88,000 | ..... | Ultimate strength. Sheared rivets. |

Shearing strength of rivets = 39,820 pounds per square inch.

## No. 250.

## ¼″ Iron Plate.




Five ⅝″ iron rivets; drilled holes ″.69 diameter.
Corners of rivet holes rounded about ″.05.
Shearing area of rivets (5 = ″.69 diameter), 1.87 square inches.

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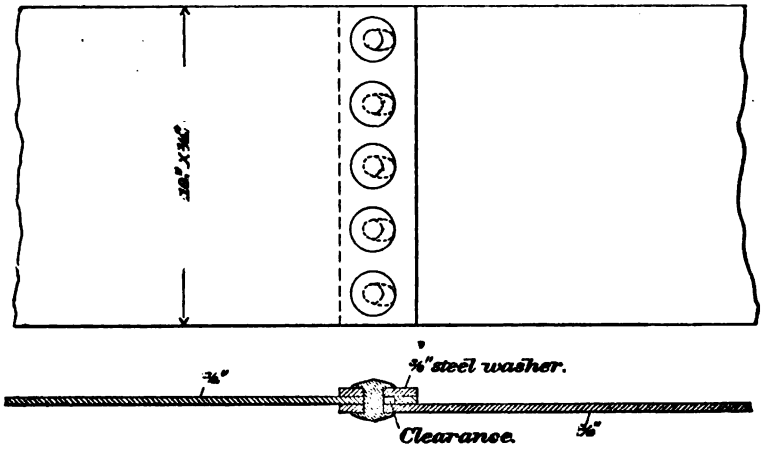
| Loads applied. | Elongation in 10 inches. | Permanent set. | Remarks. |
|---|---|---|---|
| *Pounds.* | *Inch.* | *Inch.* | |
| 5,000 | 0. | ..... | |
| 10,000 | .0015 | ..... | |
| 12,000 | .0020 | ..... | |
| 14,000 | .0025 | ..... | |
| 16,000 | .0032 | ..... | |
| 18,000 | .0040 | ..... | |
| 20,000 | .0050 | ..... | |
| 21,000 | .0058 | ..... | |
| 22,000 | .0065 | ..... | |
| 23,000 | .0070 | ..... | |
| 24,000 | .0080 | ..... | |
| 25,000 | .0092 | ..... | |
| 5,000 | ..... | .0045 | |
| 26,000 | .0110 | ..... | Friction per rivet, $\frac{26}{5}$ = 5,200 pounds. |
| 27,000 | .1230 | ..... | |
| 28,000 | .1260 | ..... | |
| 29,000 | .1410 | ..... | |
| 30,000 | .1520 | ..... | |
| 35,000 | .220 | ..... | |
| 40,000 | .25 | ..... | |
| 45,000 | .29 | ..... | |
| 50,000 | .32 | ..... | |
| 60,000 | .37 | ..... | |
| 70,900 | ..... | ..... | Sheared rivets. |

Shearing strength of rivets = 37,914 pounds per square inch.

## No. 251.

### ¼″ Steel Plate.




Five ⅝″ iron rivets (Burden's); drilled holes, ″.69 diameter.
Rivet holes rounded about ″.05.
Shearing area of rivets, 1.87 square inches.

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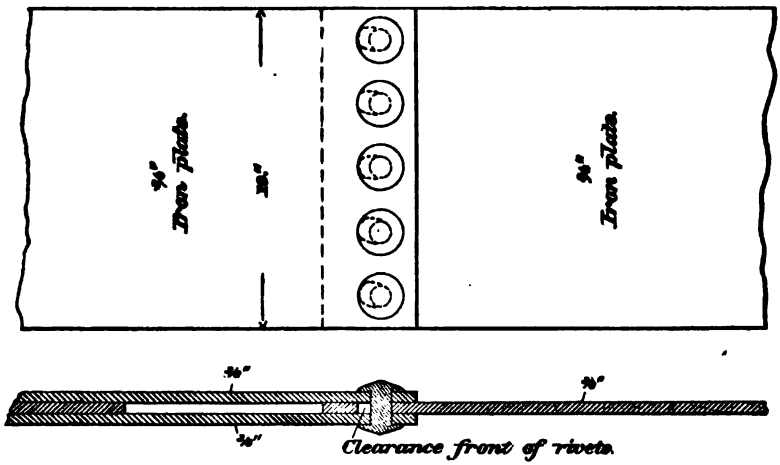
| Loads applied. | Elongation in 10 inches. | Permanent set. | Remarks. |
|---|---|---|---|
| *Pounds.* | *Inch.* | *Inch.* | |
| 5,000 | 0. | | |
| 10,000 | .0010 | | |
| 12,000 | .0018 | | |
| 14,000 | .0028 | | |
| 16,000 | .0082 | | |
| 5,000 | | 0.0008 | |
| 16,000 | .0082 | | |
| 18,000 | .0040 | | |
| 20,000 | .0050 | | |
| 5,000 | | .0020 | |
| 21,000 | .0058 | | |
| 22,000 | .0062 | | |
| 23,000 | .0070 | | |
| 24,000 | .0078 | | |
| 25,000 | .0082 | | |
| 26,000 | .0090 | | $\frac{17}{32}$ × $\frac{29}{32}$ = 5,400 pounds sudden slip. |
| 27,000 | .0100 | | |
| 28,000 | .0128 | | |
| 29,000 | .0132 | | |
| 30,000 | .0162 | | Friction per rivet, $\frac{29}{32}$ × $\frac{32}{32}$ = 6,000 pounds. |
| 31,000 | .0640 | | |
| 32,000 | .0710 | | |
| 33,000 | .0935 | | |
| 34,000 | .0990 | | |
| 35,000 | .1660 | | |
| 36,000 | .172 | | |
| 37,000 | .182 | | |
| 40,000 | .260 | | |
| 45,000 | .295 | | |
| 50,000 | .325 | | |
| 60,000 | .380 | | |
| 72,700 | | | Sheared the rivets. |

**Shearing strength of rivets, 38,880 pounds per square inch.**

## No. 636.

## $\frac{3}{8}$″ Iron Plate.

### FRICTION OF RIVETS.




**Five $\frac{3}{4}$″ iron rivets; drilled holes, ″.81 diameter.**



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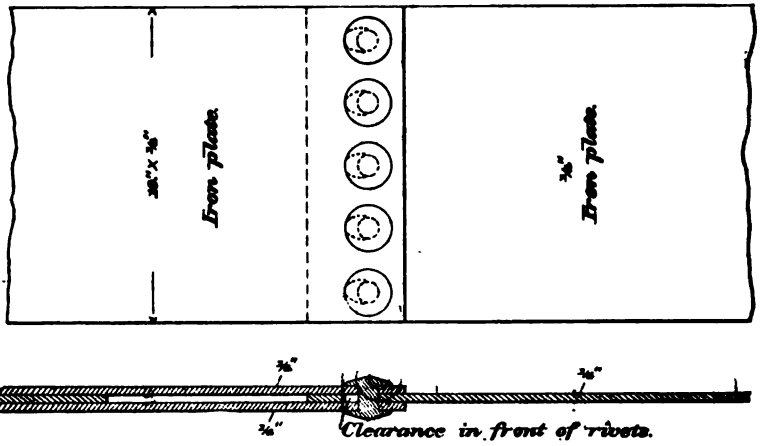
| Loads applied. | Elongation in 10 inches. | Remarks. |
|---|---|---|
| *Pounds.* | *Inch.* | |
| 5,000 | 0. | |
| 10,000 | 0. | |
| 15,000 | .0005 | |
| 20,000 | .0008 | |
| 25,000 | .0010 | |
| 30,000 | .0018 | |
| 33,000 | .0020 | |
| 35,000 | .0022 | |
| 38,000 | .0028 | |
| 40,000 | .0030 | |
| 42,000 | .0032 | |
| 44,000 | .0038 | |
| 46,000 | .0040 | |
| 48,000 | .0048 | |
| 50,000 | .0069 | |
| 52,000 | .3470 | Sudden slip of plates. |

10,400 pounds friction per rivet.

No. 637.

$\frac{1}{4}$″ IRON PLATE.

FRICTION OF RIVETS.




Five $\frac{11}{16}$″ iron rivets; drilled holes, $\frac{3}{4}$″ diameter.

| Loads applied. | Elongation in 10 inches. | Remarks. |
|---|---|---|
| *Pounds.* | *Inch.* | |
| 5,000 | 0. | |
| 10,000 | 0. | |
| 20,000 | .0008 | |
| 30,000 | .0020 | |
| 38,000 | .0106 | Rapid slipping of plates. |

7,600 pounds friction per rivet.

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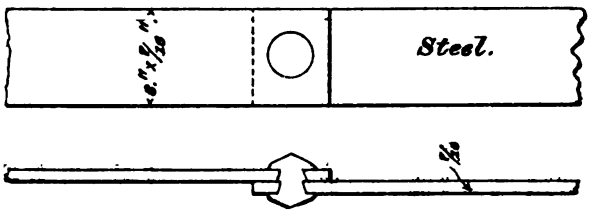
SHEARING OF STEEL RIVETS.




No. 467.

FIRST RIVET.

$1\frac{1}{16}$" steel rivet. (Kind of steel not known.)
Punched holes: Punch, ".753 diameter; die, ".774 diameter.
Shearing area of rivet, .45 square inch.
Ultimate shearing strength, 25,750 pounds = 57,220 pounds per square inch.

No. 468.

SECOND RIVET.

Ultimate shearing strength, 26,490 = 58,870 pounds per square inch.

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## ANALYSIS OF IRON, STEEL, ETC.

[Made by Capt. JOHN PITMAN, Ordnance Department.]

10" RODMAN GUNS, Nos. 362 AND 363.

| | No. 362. | No. 363. | Difference. |
|---|---|---|---|
| | *Per cent.* | *Per cent.* | *Per cent.* |
| Silicon | 1.765 | 1.750 | 0.015 |
| Phosphorus | 0.144 | 0.130 | 0.014 |
| Sulphur | 0.109 | 0.098 | 0.011 |
| Manganese | 0.500 | 0.433 | 0.067 |
| Copper | 0.094 | 0.086 | 0.002 |
| Cobalt | 0.016 | 0.008 | 0.008 |
| Nickel | 0.010 | 0.015 | 0.005 |
| Combined carbon | 0.559 | 0.697 | 0.138 |
| Graphite | 2.432 | 2.130 | 0.302 |
| Total carbon | 2.991 | 2.827 | 0.164 |

STEEL PLATES USED FOR EXPERIMENTS ON RIVETED JOINTS.

| | ½" steel. | ⅝" steel. | ¾" steel. |
|---|---|---|---|
| | *Per cent.* | *Per cent.* | *Per cent.* |
| Carbon | 0.115 | 0.126 | 0.130 |

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### STEEL BARS.

[Supposed to be alike.]

| | Carbon. | | Carbon. | Tensile strength per square inch. |
|---|---|---|---|---|
| | | | | *Pounds.* |
| No. 1 | 0.173 | Duplicate..... | 0.187 | 60,445 |
| No. 2 | 0.087 | ... do ..... | 0.094 | 60,185 |
| No. 3 | 0.553 | ....do ..... | 0.565 | 74,896+ |
| No. 4 | 0.180 | ... do ..... | 0.188 | 63,230 |
| No. 5 | 0.234 | ...do ..... | 0.210 | 62,640 |
| No. 6 | 0.128 | ....do ..... | 0.129 | 59,730 |
| No. 7 | 0.174 | ....do ..... | 0.183 | 66,069 |
| No. 8 | 0.198 | ....do ..... | 0.208 | 59,545 |
| No. 9 | 0.172 | ..... | ..... | 59,760 |

### BRONZE, ETC.

| | Copper. | Nickel and cobalt. | Zinc. | Tin. | Iron. | Antimony. | Arsenic. | Lead. | Bismuth. | Silver. |
|---|---|---|---|---|---|---|---|---|---|---|
| | *Per cent.* | *Per cent.* | *Per cent.* | *Per cent.* | *Per cent.* | *Per cent.* | *Per cent.* | *Per cent.* | *Per cent.* | *Per cent.* |
| Hub from cavalry forge wheel.... | 86.35 | ..... | 3.56 | 9.94 | 0.040 | ..... | ..... | 0.130 | 0.010 | ..... |
| Alloy from Rock Island ..... | 0.175 | 0.157 | 0.020 | 0.438 | 0.150 | 5.905 | 0.041 | 93.000 | 0.052 | Trace. |
| Brazing Wood bridge gun..... | 58.85 | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... |
| Trunnion Wood bridge gun..... | 3.53 | ..... | ..... | ..... | 92.64 | ..... | ..... | ..... | ..... | ..... |
| Crab obelisk .... | 91.08 | ..... | ..... | 8.33 | 0.09 | ..... | ..... | ..... | ..... | ..... |

## *Tensile test of wrought iron used in spliced specimens Nos.* 607, 608, 609, *and* 610.

### FORM OF TENSILE SPECIMENS.

| Number of test. | Mark on specimen. | Size of specimen. | | Sectional area. | Elastic limit. | | Ultimate strength. | |
|---|---|---|---|---|---|---|---|---|
| | | Thickness. | Width. | | Actual pounds. | Pounds per square inch. | Actual pounds. | Pounds per square inch. |
| | | *Inch.* | *Inch.* | *Square inch.* | | | | |
| 605 | C | .388 | 1.500 | .5820 | 20,200 | 34,708 | 28,500 | 48,970 |
| 606 | R | .373 | 1.503 | .5606 | 18,050 | 32,200 | 24,100 | 42,990 |

| Number of test. | Elongation in 10 inches. | Uniform elongation. | Area at fracture. | Contraction of area. | Appearance of fracture. |
|---|---|---|---|---|---|
| | *Per cent.* | *Per cent.* | *Square inch.* | *Per cent.* | |
| 605 | 10.5 | 9 | .34 × 1.47=.4998 | 14.1 | Fibrous lamellar. |
| 606 | 6.9 | 6 | .34 × 1.44=.4896 | 12.7 | Do. |

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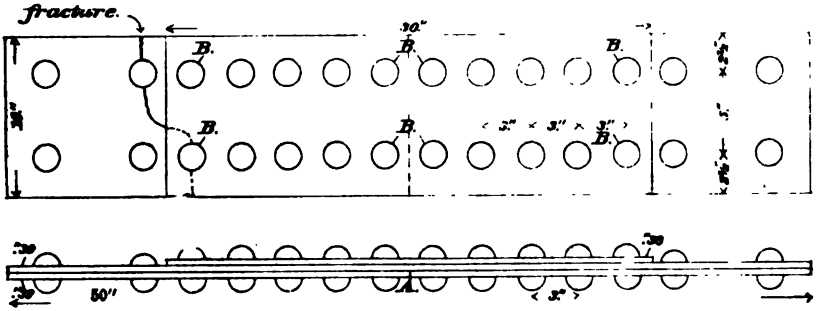
No. 607.

*Tensile test of $\frac{3}{8}$″ × 10″ wrought-iron spliced plates.*




$\frac{11}{16}$″ iron rivets, "Burden's best."

$\frac{7}{8}$″ drilled holes.

No. 607.

Gross sectional area of two spliced plates ″.78 × 10″ = 7.8 square inches.

Net sectional area of two spliced plates, ″.78 × 8″.25 = 6.44 square inches.

Under load of 80,000 pounds, joint *A* of under spliced plate opened perceptibly.

While sustaining 150,000 pounds a straight edge 24″ long was placed on the welt and deflection of ″.13 at middle found, plates being concave on the side of the welt at 170,000 pounds tension. Joint *A* had opened from ″.03 to ″.04. At this load scale had started on rivet-heads *B* on sides towards middle of specimen. A load of 210,000 pounds was applied and then reduced to zero load, leaving a permanent deflection of ″.20 at middle, as measured from a 24″ straight edge.

Ultimate strength of plates, 258,500 pounds, fracturing specimen at end rivet in welt on one side and at first rivet beyond welt on the other side of the plates.

Fracture fibrous lamellar.

*Maximum strain on joint.*

| | Pounds per sq. inch. |
|---|---|
| Tensile strain on gross section of plates | 33,141 |
| Tensile strain on net section of plates | 40,140 |

No. 608.

Duplicate of No. 607.

Gross sectional area of spliced plates, ″.76 × 10″ = 7.6 square inches.

Net sectional area of spliced plates, ″.76 × 8″.25 = 6.27 square inches.

| Loads applied. | Remarks. |
|---|---|
| *Pounds.* | |
| 50,000 | Deflection at middle, ″.03, measured from 24″ straight edge. |
| 100,000 | Deflection at middle, ″.07, measured from 24″ straight edge. |
| 150,000 | Deflection at middle, ″.11, measured from 24″ straight edge. |
| 200,000 | Deflection at middle, ″.17, measured from 24″ straight edge. |
| 0 | Deflection at middle, ″.11, measured from 24″ straight edge. |
| 250,000 | Deflection at middle, ″.27, measured from 24″ straight edge. |
| 279,100 | Ultimate strength. |

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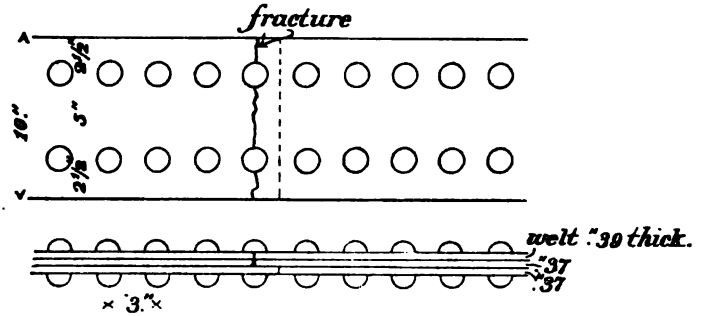
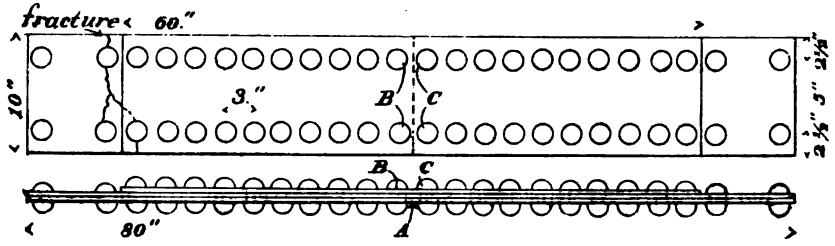
Fractured the continuous plate and the welt at the middle of the specimen at the first rivets from joint.




*Maximum loads on joint.*

| | Pounds per sq. inch. |
|---|---|
| Tensile strain on gross section of plates | 36,724 |
| Tensile strain on net section of plates | 44,514 |

No. 609.




Nominal thickness of plates, $\frac{3}{8}$".
$\frac{13}{16}$" iron rivets, "Burden's best"; $\frac{7}{8}$" drilled holes.
Gross sectional area of spliced plates, ".73 × 10" = 7.3 square inches.
Net sectional area of spliced plates, ".73 × 8".25 = 6.02 square inches.

| Loads applied. | Remarks. |
|---|---|
| *Pounds.* | |
| 50,000 | Deflection at middle, ".02, measured from 24" straight edge. |
| 100,000 | Deflection at middle, ".04, measured from 24" straight edge. |
| 150,000 | Deflection at middle, ".06, measured from 24" straight edge. |
| 200,000 | Deflection at middle, ".07, measured from 24" straight edge. |
| 240,000 | Deflection at middle, ".06, measured from 24" straight edge. |
| 254,800 | Ultimate strength. |

Fractured plate in the same manner as No. 607; failed.

Plates began to tear at rivet holes after the joint *A* was open ".20, the result of the distortion of the joint and the stretch of the welt and continuous plate for the section between rivets *B* and *C*.

*Maximum loads on joint.*

| | Pounds per sq. inch. |
|---|---|
| Tensile strain on gross section of plates | 34,900 |
| Tensile strain on net section of plates | 42,325 |

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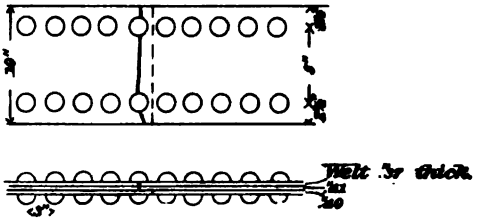
No. 610.

Duplicate of No. 609.
Gross sectional area of spliced plates, $''.81 \times 10'' = 8.1$ square inches.
Net sectional area of spliced plates, $''.81 \times 8''.25 = 6.68$ square inches.

| Loads applied. | Remarks. |
|---|---|
| *Pounds.* | |
| 50,000 | Deflection at middle, ".02, measured from 24" straight edge. |
| 100,000 | Deflection at middle, ".04, measured from 24" straight edge. |
| 150,000 | Deflection at middle, ".05, measured from 24" straight edge. |
| 200,000 | Deflection at middle, ".08, measured from 24" straight edge. |
| 240,000 | Deflection at middle, ".10, measured from 24" straight edge. |
| 273,200 | Ultimate strength. |

Fractured continuous plate and welt at middle of specimen at first rivets from joint.




*Maximum loads on joint.*

| | Pounds per sq. inch |
|---|---|
| Tensile strain on gross section of plates | 33,728 |
| Tensile strain on net section of plates | 40,898 |

*Tensile tests of old boiler joints.*

$\frac{3}{8}''$ Wrought Iron Plate.

Specimens taken from the cylindrical part of a locomotive boiler which had been in service twenty-four years.
Diameter of shell, 52".
Steam pressure carried, 130 pounds per square inch.
Tensile test-piece No. 80 cut out crosswise the grain.
Joints Nos. 89, 90, and 91 tested lengthwise the grain of the iron.

No. 80.

Sectional area, $1''.500 \times ''.385 = .577$ square inch.
Elastic limit, 13,600 pounds = 23,570 pounds per square inch.
Ultimate strength, 26,200 pounds = 45,410 pounds per square inch.
Elongation, 1".34 in 10" = 13.4 per cent.
Uniform elongation, 10 per cent.
Area at fracture, $1''.37 \times ''.32 = .438$ square inch.
Contraction of area, 24.1 per cent.
Appearance of fracture fibrous, with marked lamination.

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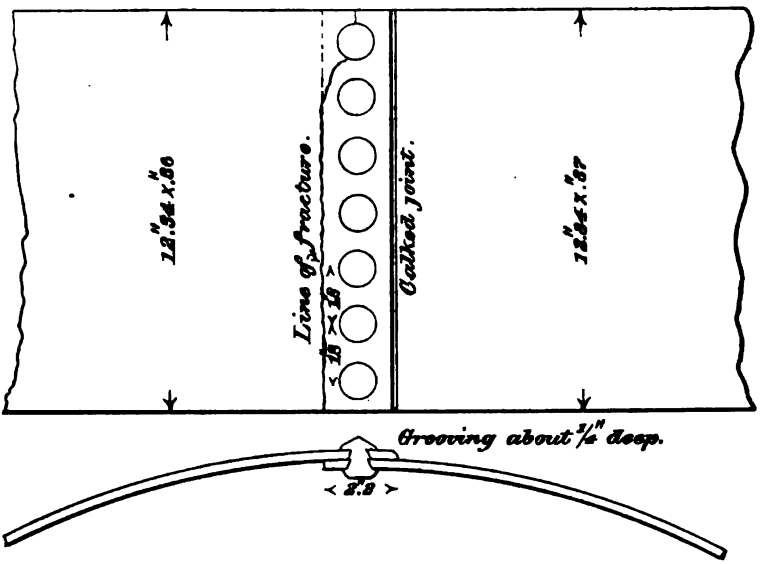
No. 89.

OLD BOILER PLATE JOINT, $\frac{3}{8}$" WROUGHT IRON.




⅞" Iron rivets. Hand driven. Punched holes.

The curve of the joint (conforming to the curvature of the shell of the boiler, 52" diameter) was not straightened before placing in the testing machine. At 10,000 pounds tension the plate had straightened so as to open the crack where grooving had taken place. This crack did not appear before placing the specimen in the machine, as it followed the edge of the overlapping plate in part, and for part of its course was covered by the overlapping plate. As strains were increased this crack gradually opened. At 59,700 pounds tension snapping sounds were heard, which were heard frequently till the ultimate strength was determined.

Ultimate strength, 84,300 pounds.

Fracture occurred along the line where grooving had taken place, a distance of 10", then turning in its course slightly and tearing through the end rivet hole. Appearance of fracture dull, fibrous, and fine granular. The minimum thickness of metal at bottom of grooving was about ".06. The average thickness about ".09 for 10" length.

The area of fractured plate probably about 1.6 square inches.

The pull exerted by the machine tending to straighten the joint may have caused a more unfavorable effect on the plate and caused earlier ailure than would have been the case when the plate was in the boiler, he plate fracturing under the combined tensile and bending strains.

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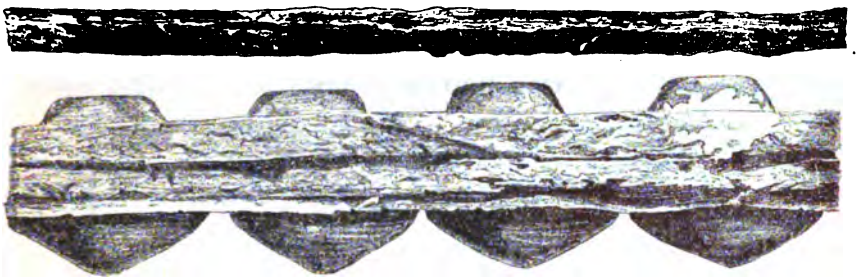
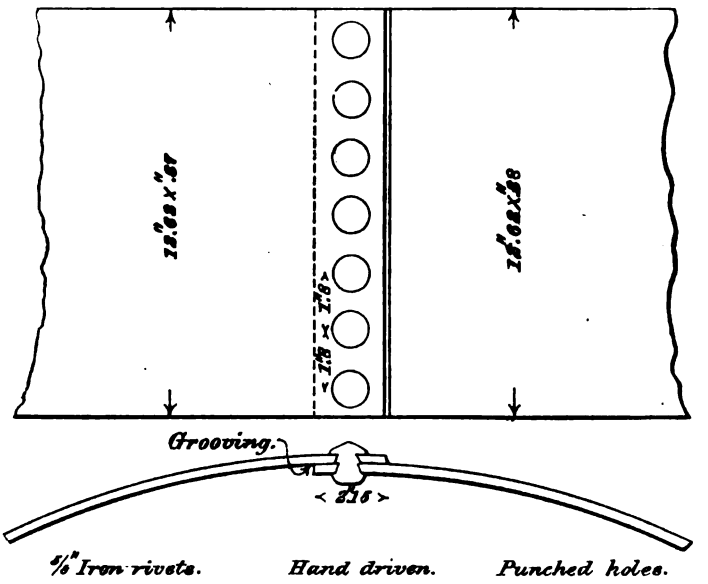


No. 90.

OLD BOILER PLATE JOINT, $\frac{3}{8}$" WROUGHT IRON.




Snapping sound heard at 56,000 pounds tension.

Ultimate strength, 83,500 pounds. Sheared rivets.

This joint was cleaned and carefully examined before the test was made to detect evidence of grooving, if any had taken place.

The inspection did not reveal any cracks from grooving. When, however, a tensile strain of 50,000 pounds had been reached, the grooving cracks appeared.

After having sheared the rivets in the first test of this joint, the grooved plate was placed in the testing machine and strains applied so as to fracture the plate through the grooving. This was accomplished by a tensile strain of 206,500 pounds.

The grooving had extended to an average depth of ".07. The appearance of the fractured metal was fibrous, with very marked lamination.

The head of a rivet was fractured, showing a granular appearance.

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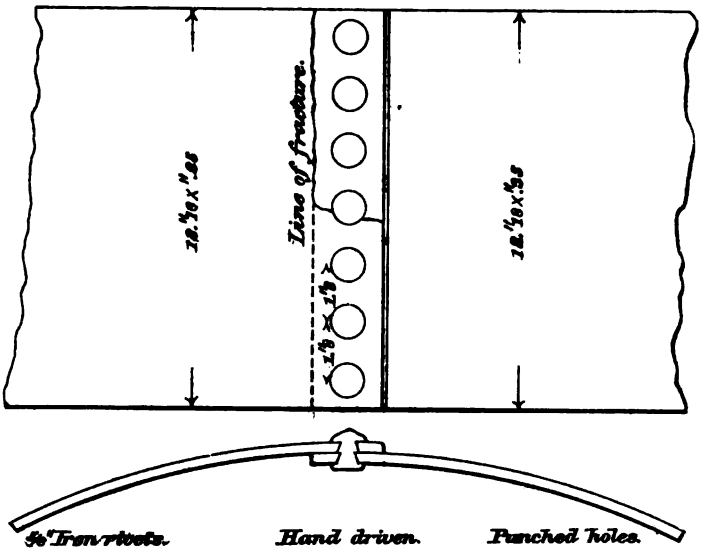
No. 91.

OLD BOILER PLATE.




Before placing this joint in the testing machine it was cleaned and carefully inspected, and by means of a scratch-awl grooving was detected in three places, having an aggregate length of $4\frac{3}{4}$". An opinion at this time could not be formed as to the depth of the grooving. The cracks could not be followed with the point of the awl beyond the distance of $4\frac{3}{4}$".

When a tensile strain was applied and the joint began to straighten, the grooving opened a length of 12". Ultimate strength of joint, 84,200 pounds. Sheared five rivets and tore the plate along the line of grooving 6", and through a rivet hole to the end of the lap. Maximum depth of grooving, ".28.

From the fact that more than half the length of the grooving could not be seen before the test was made, it would appear very probable that cases of grooving exist that are wholly covered by the overlapping plate, and its presence even after a careful examination of the boiler is unsuspected.

The plate fractured with a fibrous appearance, slightly granular.

Appearance of fractured plate, Joint No. 91.

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*Tensile tests of single and double refined wrought iron.*

ROUND BARS.

(Single refined bars from the Passaic Rolling Mill Company, Paterson, N. J.)

[FORM OF SPECIMENS.]

No. 593.

Mark on bar, S. 18.
Diameter, 2″.01.
Sectional area, 3.17 square inches.
Gauged length, 80″.

| Loads applied. | Pounds per square inch. | Elongation. | Permanent set. | Remarks. |
|---|---|---|---|---|
| *Pounds.* | | *Inch.* | *Inch.* | |
| 3,170 | 1,000 | 0. | | |
| 15,850 | 5,000 | .0127 | | |
| 31,700 | 10,000 | .0275 | | |
| | 1,000 | | 0. | |
| 47,550 | 15,000 | .0425 | | |
| 63,400 | 20,000 | .0572 | | |
| | 1,000 | | 0. | |
| 65,000 | | .0600 | | |
| 66,000 | | .0608 | | |
| 67,000 | | .0618 | | |
| 68,000 | | .0628 | | |
| 69,000 | | .0637 | | |
| 70,000 | | .0650 | | |
| 71,000 | | .0659 | | |
| 72,000 | | .0669 | | |
| 73,000 | | .0679 | | |
| 74,000 | | .0690 | | |
| 75,000 | | .0699 | | |
| 76,000 | | .0710 | | |
| 77,000 | | .0721 | | |
| 78,000 | 24,609 | .0733 | | Elastic limit. |
| 79,000 | | .0748 | | |
| 80,000 | | .0760 | | |
| 81,000 | | .0797 | | |
| 82,000 | | .0815 | | |
| 83,000 | | .0829 | | |
| 84,000 | | .0850 | | |
| 85,000 | | .0874 | | |
| 86,000 | | .0925 | | |
| 87,000 | | .0945 | | |
| 88,000 | | .0968 | | |
| 90,000 | | .1015 | | |
| 92,000 | | .650 | | Sustained load 5 minutes. |
| 95,100 | 30,000 | .90 | | |
| 110,950 | 35,000 | 2.12 | | |
| 126,800 | 40,000 | 3.82 | | Elongation of 10″ sections: ″.81, ″.86, ″.89, ″.88, ″.88, ″.89, ″.89, ″.87. |
| 142,650 | 45,000 | 6.84 | | |
| 154,400 | | 12.00 | | |
| 0 | 0 | | | Rested 5 minutes. |
| 157,500 | 49,680 | 15.20 | | Ultimate strength. |
| 0 | 0 | 15.58 | | = 19.5 per cent. |

Elongation of 10″ sections: 1″.67 (2″.45 at fracture), 1″.92, 1″.90, 1″.89, 1″.96, 1″.95, 1″.90.
Diameter at fracture, 1″.66; area, 2.16 square inches.
Contraction of area, 32 per cent.
Fracture fibrous, slightly granular.

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No. 594.

Mark on bar, S 19.
Diameter, 2″.01.
Sectional area, 3.17 square inches.
Gauged length, 80″.

| Loads applied. | Pounds per square inch. | Elongation. | Permanent set. | Remarks. |
|---|---|---|---|---|
| *Pounds.* | | *Inch.* | *Inch.* | |
| 3,170 | 1,000 | 0. | | |
| 15,850 | 5,000 | .0120 | | |
| 31,700 | 10,000 | .0260 | | |
| | 1,000 | | 0. | |
| 47,550 | 15,000 | .0406 | | |
| 63,400 | 20,000 | .0545 | | |
| | 1,000 | | —.0006 | |
| 65,000 | | .0555 | | |
| 66,000 | | .0563 | | |
| 67,000 | | .0572 | | |
| 68,000 | | .0581 | | |
| 69,000 | | .0590 | | |
| 70,000 | | .0600 | | |
| 71,000 | | .0610 | | |
| 72,000 | | .0620 | | |
| 73,000 | | .0630 | | |
| 74,000 | | .0640 | | |
| 75,000 | | .0650 | | |
| 76,000 | | .0661 | | |
| 77,000 | | .0671 | | |
| 78,000 | | .0681 | | |
| 79,000 | | .0694 | | |
| 80,000 | | .0705 | | |
| 81,000 | | .0716 | | |
| 82,000 | 25,870 | .0729 | | Elastic limit. |
| 83,000 | | .0745 | | |
| 84,000 | | .0758 | | |
| 85,000 | | .0777 | | |
| 86,000 | | .0796 | | |
| 87,000 | | .0813 | | |
| 88,000 | | .0835 | | |
| 89,000 | | .0867 | | |
| 90,000 | | .185 | | Sustained load 5 minutes; stretching still going on. |
| 95,100 | 30,000 | 1.00 | | |
| 110,950 | 35,000 | 2.29 | | |
| 126,800 | 40,000 | 4.06 | | Elongation of 10″ sections: ″.88, ″.89, ″.90, ″.90, ″.88, ″.89, ″.89, ″.85. |
| 142,650 | 45,000 | 7.00 | | |
| 156,400 | 49,338 | | | Ultimate strength. |
| 0 | 0 | 14.66 | | =18.3 per cent. |

Elongation of 10″ sections: 1″.65, 1″.72, 1″.70, 1″.69, 1″.81, 1″.90 (2″.50 at fracture), 1″.70.
Diameter at fracture, 1″.58; area, 1.96 square inches.
Contraction of area, 38 per cent.
Fracture, fibrous.

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No. 595.

Mark on bar, S 20.
Diameter, 2″.01; sectional area, 3.17 square inches.
Gauged length, 80″.

| Loads applied. | Pounds per square inch. | Elongation. | Permanent set. | Remarks. |
|---|---|---|---|---|
| *Pounds.* | | *Inch.* | *Inch.* | |
| 3,170 | 1,000 | 0. | | |
| 15,850 | 5,000 | .0120 | | |
| 31,700 | 10,000 | .0270 | | |
| | 1,000 | | —.0005 | |
| 47,550 | 15,000 | .0424 | | |
| 63,400 | 20,000 | .0577 | | |
| | 1,000 | | .0014 | |
| 65,000 | | .0597 | | |
| 66,000 | | .0605 | | |
| 67,000 | | .0618 | | |
| 68,000 | | .0629 | | |
| 69,000 | | .0639 | | |
| 70,000 | | .0650 | | |
| 71,000 | | .0660 | | |
| 72,000 | | .0670 | | |
| 73,000 | | .0681 | | |
| 74,000 | | .0696 | | |
| 75,000 | | .0708 | | |
| 76,000 | | .0724 | | |
| 77,000 | | .0735 | | |
| 78,000 | | .0748 | | |
| 79,000 | 24,920 | .0760 | | Elastic limit. |
| 80,000 | | .0775 | | |
| 81,000 | | .0788 | | |
| 82,000 | | .0805 | | |
| 83,000 | | .0820 | | |
| 84,000 | | .0834 | | |
| 85,000 | | .0850 | | |
| 86,000 | | .0868 | | |
| 87,000 | | .0889 | | |
| 88,000 | | .0938 | | |
| 89,000 | | .205 | | Yielding continues. |
| 95,100 | 30,000 | 1.00 | | |
| 110,950 | 35,000 | 2.25 | | |
| 126,800 | 40,000 | 4.10 | | Elongation of 10″ sections: ″.87, ″.93, ″.92, ″.93, ″.92, ″.91, ″.91, ″.90. |
| 142,650 | 45,000 | 7.30 | | |
| 154,900 | 48,864 | | | Ultimate strength. |
| 0 | 0 | 14.69 | | =18.4 per cent. |

Elongation of 10″ sections: 1″.62 (2″.34 at fracture), 1″.75, 1″.82, 1″.81, 1″.81, 1″.75, 1″.79.
Diameter at fracture, 1″.59; area, 1.99 square inches.
Contraction of area, 37 per cent.
Appearance of fracture fibrous, with some cinder at center.

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## DOUBLE-REFINED WROUGHT IRON.

### No. 596.

Mark on bar, S 218.
Diameter, 2″.01; sectional area, 3.17 square inches.
Gauged length, 80″.

| Loads applied. | Pounds per square inch. | Elongation. | Permanent set. | Remarks. |
|---|---|---|---|---|
| *Pounds.* | | *Inch.* | *Inch.* | |
| 3,170 | 1,000 | 0. | | |
| 15,850 | 5,000 | .0119 | | |
| 31,700 | 10,000 | .0268 | | |
| | 1,000 | | −.0009 | |
| 47,550 | 15,000 | .0415 | | |
| 63,400 | 20,000 | .0559 | | |
| | 1,000 | | −.0013 | |
| 65,000 | | .0570 | | |
| 66,000 | | .0580 | | |
| 67,000 | | .0590 | | |
| 68,000 | | .0600 | | |
| 69,000 | | .0610 | | |
| 70,000 | | .0620 | | |
| 71,000 | | .0630 | | |
| 72,000 | | .0640 | | |
| 73,000 | | .0650 | | |
| 74,000 | | .0660 | | |
| 75,000 | | .0670 | | |
| 76,000 | | .0680 | | |
| 77,000 | | .0690 | | |
| 78,000 | 24,610 | .0703 | | Elastic limit. |
| 79,000 | | .0716 | | |
| 80,000 | | .0729 | | |
| 81,000 | | .0740 | | |
| 82,000 | | .0751 | | |
| 83,000 | | .0762 | | |
| 84,000 | | .0777 | | |
| 85,000 | | .0789 | | |
| 86,000 | | .0805 | | |
| 87,000 | | .0820 | | |
| 88,000 | | .0833 | | |
| 89,000 | | .0850 | | |
| 90,000 | | .0865 | | |
| 91,000 | | .0882 | | |
| 92,000 | | .0902 | | |
| 93,000 | | .0956 | | |
| 94,000 | | .1650 | | |
| 95,100 | 30,000 | .47 | | |
| 110,950 | 35,000 | 2.10 | | |
| 126,800 | 40,000 | 3.75 | | Elongation of 10″ sections: ″.51, ″.81, ″.83, ″.84, ″.83, ″.85, ″.80, ″.81. |
| 142,650 | 45,000 | 6.55 | | |
| 158,500 | | | | Rested 3 minutes. |
| 0 | 0 | | | Ultimate strength. |
| 160,500 | 50,631 | 16.35 | | =20.4 per cent. |
| 0 | 0 | | | |

Elongation of 10″ sections: 1″.90, 1″.95, 2″.19, 2″.08, 2″.01, 2″.09, 1″.97, 2″.13.

Diameter at fracture, 1″.54; area, 1.86 square inches.

Contraction of area, 41 per cent.

Fracture fibrous; broke outside 80″ section, 2″ from face of holder jaws.

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## No. 597.

**Mark on bar, S 219.**
**Diameter, 2″.01; sectional area, 3.17 square inches.**
**Gauged length, 80″.**

| Loads applied. | Pounds per square inch. | Elongation. | Permanent set. | Remarks. |
|---|---|---|---|---|
| *Pounds.* | | *Inch.* | *Inch.* | |
| 3,170 | 1,000 | 0. | | |
| 15,850 | 5,000 | .0124 | | |
| 31,700 | 10,000 | .0270 | | |
| | 1,000 | | 0. | |
| 47,550 | 15,000 | .0423 | | |
| 63,400 | 20,000 | .0566 | | |
| | 1,000 | | 0. | |
| 65,000 | | .0580 | | |
| 66,000 | | .0591 | | |
| 67,000 | | .0600 | | |
| 68,000 | | .0610 | | |
| 69,000 | | .0620 | | |
| 70,000 | | .0630 | | |
| 71,000 | | .0640 | | |
| 72,000 | | .0649 | | |
| 73,000 | | .0660 | | |
| 74,000 | | .0668 | | |
| 75,000 | | .0675 | | |
| 76,000 | | .0685 | | |
| 77,000 | | .0695 | | |
| 78,000 | | .0704 | | |
| 79,250 | 25,000 | .0718 | | |
| | 1,000 | | .0065 | |
| 80,000 | | .0728 | | |
| 81,000 | | .0740 | | |
| 82,000 | | .0750 | | |
| 83,000 | | .0762 | | |
| 84,000 | | .0774 | | |
| 85,000 | | .0785 | | |
| 86,000 | | .0798 | | |
| 87,000 | | .0811 | | |
| 88,000 | | .0824 | | |
| 89,000 | | .0840 | | |
| 90,000 | | .0852 | | |
| 91,000 | | .0868 | | |
| 92,000 | | .0885 | | |
| 93,000 | | .0902 | | |
| 94,000 | | .0918 | | |
| 95,000 | | .0935 | | |
| 96,000 | | .0968 | | |
| 97,000 | | .315* | | |
| 98,000 | | .97 | | Sustained load 5 minutes. |
| 110,950 | 35,000 | 1.90 | | |
| 126,800 | 40,000 | 3.50 | | Elongation of 10″ sections: ″.76, ″.76, ″.78, ″.78, ″.79, ″80, ″.79, ″.78. |
| 142,650 | 45,000 | 6.16 | | |
| 160,500 | | | | |
| 0 | 0 | | | Rested 3 minutes. |
| 161,400 | 50,915 | | | Ultimate strength. |
| 0 | 0 | 20.37 | | =25.5 per cent. |

* About.

**Elongation of 10″ sections: 2″.19, 2″.26, 2″.49, 2″.40 (2″.95 at fracture), 2″.90, 2″.44, 2″.72.**
**Diameter at fracture, 1″.50; area, 1.77 square inches.**
**Contraction of area, 44 per cent.**
**Fracture fibrous, cup-shaped.**

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## No. 598.

Mark on bar, S 220.
Diameter, 2″.01; sectional area, 3.17 square inches.
Gauged length, 80″.

| Loads applied. | Pounds per square inch. | Elongation. | Permanent set. | Remarks. |
|---|---|---|---|---|
| *Pounds.* | | *Inch.* | *Inch.* | |
| 3,170 | 1,000 | 0. | | |
| 15,850 | 5,000 | .0120 | | |
| 31,700 | 10,000 | .0270 | | |
| | 1,000 | | .0003 | |
| 47,550 | 15,000 | .0421 | | |
| 64,400 | 20,000 | .0570 | | |
| | 1,000 | | .0015 | |
| 65,000 | | .0588 | | |
| 66,000 | | .0600 | | |
| 67,000 | | .0610 | | |
| 68,000 | | .0619 | | |
| 69,000 | | .0629 | | |
| 70,000 | | .0640 | | |
| 71,000 | | .0650 | | |
| 72,000 | | .0660 | | |
| 73,000 | | .0670 | | |
| 74,000 | | .0680 | | |
| 75,000 | | .0690 | | |
| 76,000 | | .0701 | | |
| 77,000 | | .0714 | | |
| 78,000 | | .0725 | | |
| 79,250 | 25,000 | .0738 | | |
| | 1,000 | | .0047 | |
| 80,000 | | .0750 | | |
| 81,000 | | .0762 | | |
| 82,000 | | .0775 | | |
| 83,000 | | .0790 | | |
| 84,000 | | .0803 | | |
| 85,000 | | .0820 | | |
| 86,000 | | .0831 | | |
| 87,000 | | .0848 | | |
| 88,000 | | .0869 | | |
| 89,000 | | .0890 | | |
| 90,000 | | .0910 | | |
| 91,000 | | .0948 | | |
| 92,000 | | .134 | | |
| 93,000 | | .400 | | |
| 95,100 | 30,000 | .90* | | |
| 110,950 | 35,000 | 2.10* | | |
| 126,800 | 40,000 | 3.80* | | |
| 142,650 | 45,000 | 6.65* | | Elongation in 10″ sections: ″.81, ″.82, ″.86, ″.84, ″.85, ″.86, ″.83, ″.82. |
| 158,000 | | | | |
| 0 | 0 | | | Rested 3 minutes. |
| 159,150 | 50,205 | | | Ultimate strength. |
| 146,000 | | | | At time of fracture. |
| 0 | 0 | 19.00 | | =23.7 per cent. |

* About.

Elongation of 10″ sections: 2″.10, 2″.06, 2″.21, 2″.38, 2″.39 (3″.35 at fracture), 2″.30, 2″.13.
Diameter at fracture, 1″.50; area, 1.77 square inches.
Contraction of area, 44 per cent.
Fracture fibrous, cup-shaped.

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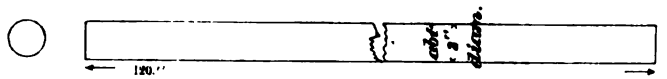
*Tensile tests of single and double refined.*

## WROUGHT IRON, ROUND BARS.

[From the Elmira Iron and Steel Rolling Mill Company.]

FORM OF SPECIMEN.




SINGLE REFINED BARS.

No. 599.

Mark on bar, L 8.
Diameter, 2".03; sectional area, 3.24 square inches.
Gauged length, 80".

| Loads applied. | Pounds per square inch. | Elongation. | Permanent set. | Remarks. |
|---|---|---|---|---|
| *Pounds.* | | *Inch.* | *Inch.* | |
| 3,240 | 1,000 | 0. | | |
| 16,200 | 5,000 | .0125 | | |
| 32,400 | 10,000 | .0270 | | |
| | 1,000 | | 0. | |
| 48,600 | 15,000 | .0422 | | |
| 64,800 | 20,000 | .0565 | | |
| | 1,000 | | —.0009 | |
| 66,000 | | .0575 | | |
| 67,000 | | .0585 | | |
| 68,000 | | .0594 | | |
| 69,000 | | .0604 | | |
| 70,000 | | .0611 | | |
| 71,000 | | .0621 | | |
| 72,000 | | .0631 | | |
| 73,000 | | .0640 | | |
| 74,000 | | .0650 | | |
| 75,000 | | .0660 | | |
| 76,000 | | .0670 | | |
| 77,000 | | .0680 | | |
| 78,000 | | .0690 | | |
| 79,000 | | .0700 | | |
| 80,000 | | .0711 | | |
| 81,000 | 25,000 | .0721 | | |
| | 1,000 | | —.0002 | |
| 82,000 | | .0739 | | |
| 83,000 | | .0750 | | |
| 84,000 | | .0762 | | |
| 85,000 | | .0775 | | |
| 86,000 | | .0787 | | |
| 87,000 | | .0801 | | |
| 88,000 | | .0815 | | |
| 89,000 | | .0831 | | |
| 90,000 | | .0843 | | |
| 91,000 | | .0859 | | |
| 92,000 | | .0874 | | |
| 93,000 | | .0890 | | |
| 94,000 | | .0909 | | |
| 95,000 | | .0936 | | |
| 96,000 | | .0970 | | |
| 97,000 | | .1053 | | |
| 98,000 | | .206 | | |
| 100,440 | 31,000 | .70 | | |
| 112,400 | 35,000 | 1.50 | | |
| 129,600 | 40,000 | 2.96 | | Elongation of 10" sections: ".70, ".70, ".69, ".69, ".69, ".68, ".68, ".66. |
| 145,800 | 45,000 | 5.35 | | |
| 166,600 | | | | Rested 3 minutes. |
| 0 | 0 | | | Ultimate strength. |
| 167,400 | 51,667 | | | = 22 per cent. |
| 0 | 0 | 17.6 | | |

Elongation of 10" sections: 2".38, 2".30, 2".19 (2".85 at fracture), 2".15, 1".96, 1".96, 1".77.
Diameter at fracture, 1".63; area, 2.09 square inches.
Contraction of area, 36 per cent.
Appearance of fracture: Fibrous, 70 per cent.; granular, 30 per cent.



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No. 600.

Mark on bar, L 9.
Diameter, 2″.02; sectional area, 3.20 square inches.
Gauged length, 80″.

| Loads applied. | Pounds per square inch. | Elongation. | Permanent set. | Remarks. |
|---|---|---|---|---|
| *Pounds.* | | *Inch.* | *Inch.* | |
| 3,200 | 1,000 | 0. | | |
| 16,000 | 5,000 | .0118 | | |
| 32,000 | 10,000 | .0265 | | |
| | 1,000 | | 0. | |
| 48,000 | 15,000 | .0429 | | |
| 64,000 | 20,000 | .0572 | | |
| | 1,000 | | —.0002 | |
| 66,000 | | .0590 | | |
| 68,000 | | .0610 | | |
| 70,000 | | .0630 | | |
| 72,000 | | .0650 | | |
| 74,000 | | .0670 | | |
| 75,000 | | .0682 | | |
| 76,000 | | .0693 | | |
| 77,000 | | .0703 | | |
| 78,000 | | .0715 | | |
| 79,000 | | .0727 | | |
| 80,000 | 25,000 | .0740 | | |
| | 1,000 | | .0624 | |
| 81,000 | | .0751 | | |
| 82,000 | | .0765 | | |
| 83,000 | | .0780 | | |
| 84,000 | | .0790 | | |
| 85,000 | | .0801 | | |
| 86,000 | | .0815 | | |
| 87,000 | | .0829 | | |
| 88,000 | | .0843 | | |
| 89,000 | | .0857 | | |
| 90,000 | | .0873 | | |
| 91,000 | | .0890 | | |
| 92,000 | | .0910 | | |
| 93,000 | | .0928 | | |
| 94,000 | | .0950 | | |
| 95,000 | | .0970 | | |
| 96,000 | | .0995 | | |
| 97,000 | | .1034 | | |
| 98,000 | | .465 | | |
| 102,200 | | .85 | | |
| 112,000 | 35,000 | 1.45 | | |
| 128,000 | 40,000 | 3.00 | | Elongations of 10″ sections: ″.66, ″.67, ″.68, ″.68, ″.70, ″.66, ″.65, ″.67. |
| 144,000 | 45,000 | 5.35 | | |
| 162,700 | 50,844 | | | Ultimate strength. |
| 0 | 0 | 13.0 | | = 16.3 per cent. |

Elongations of 10″ sections: 1″.55, 1″.60 (1″.82 at fracture), 1″.68, 1″.60, 1″.56, 1″.55, 1″.54.
Diameter at fracture, 1″.78; area, 2.51 square inches.
Contraction of area, 22 per cent.
Appearance of fracture: Fibrous, 15 per cent.; granular, 85 per cent.

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## No. 601.

Mark on bar, L 10.
Diameter, 2″.02; sectional area, 3.20 square inches.
Gauged length, 80″.

| Loads applied. | Pounds per square inch. | Elongation. | Permanent set. | Remarks. |
|---|---|---|---|---|
| *Pounds.* | | *Inch.* | *Inch.* | |
| 3,200 | 1,000 | 0. | | |
| 16,000 | 5,000 | .0125 | | |
| 32,000 | 10,000 | .0270 | | |
| | 1,000 | | .0005 | |
| 48,000 | 15,000 | .0421 | | |
| 64,000 | 20,000 | .0569 | | |
| | 1,000 | | .0005 | |
| 66,000 | | .0586 | | |
| 68,000 | | .0606 | | |
| 70,000 | | .0621 | | |
| 72,000 | | .0644 | | |
| 74,000 | | .0660 | | |
| 75,000 | | .0669 | | |
| 76,000 | | .0680 | | |
| 77,000 | | .0689 | | |
| 78,000 | | .0700 | | |
| 79,000 | | .0709 | | |
| 80,000 | 25,000 | .0719 | | |
| | 1,000 | | .0007 | |
| 81,000 | | .0730 | | |
| 82,000 | | .0736 | | |
| 83,000 | | .0746 | | |
| 84,000 | | .0757 | | |
| 85,000 | | .0767 | | |
| 86,000 | | .0780 | | |
| 87,000 | | .0790 | | |
| 88,000 | | .0800 | | |
| 89,000 | | .0811 | | |
| 90,000 | | .0824 | | |
| 91,000 | | .0837 | | |
| 92,000 | | .0854 | | |
| 93,000 | | .0865 | | |
| 94,000 | | .0881 | | |
| 95,000 | | .0900 | | |
| 96,000 | | .0916 | | |
| 97,000 | | .0931 | | |
| 98,000 | | .0950 | | |
| 99,000 | | .0971 | | |
| 100,000 | | .122 | | |
| 112,000 | 35,000 | 1.20 | | |
| 128,000 | 40,000 | 2.47 | | |
| 144,000 | 45,000 | 4.55 | | Elongations of 10″ sections: ″.55, ″.56, ″.56, ″.59, ″.58, ″.59, ″.59, ″.59. |
| 169,500 | | | | |
| 0 | 0 | | | Rested 3 minutes. |
| 169,800 | 53,062 | | | Ultimate strength at time of fracture. |
| 152,000 | | | | |
| 0 | 0 | 16.80 | | = 21 per cent. |

Elongation of 10″ sections: 1″.73, 1″.89, 1″.90, 2″.12, 2″.15, 2″.58, 2″.30, 2″.10.
Diameter at fracture, 1″.56; area, 1.91 square inches.
Contraction of area, 40 per cent.
Appearance of fracture: Fibrous, 95 per cent.; granular, 5 per cent.
Broke outside 80″ section, 6″ from face of holder jaws.

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## DOUBLE REFINED WROUGHT IRON BARS.

### No. 602.

Mark on bar, L 208.
Diameter, 2″.02; sectional area, 3.20 square inches.
Gauged length, 80″.

| Loads applied. | Pounds per square inch. | Elongation. | Permanent set. | Remarks. |
|---|---|---|---|---|
| *Pounds.* | | *Inch.* | *Inch.* | |
| 3,200 | 1,000 | 0. | | |
| 16,000 | 5,000 | .0120 | | |
| 32,000 | 10,000 | .0271 | | |
| | 1,000 | | .0020 | |
| 48,000 | 15,000 | .0421 | | |
| 64,000 | 20,000 | .0571 | | |
| | 1,000 | | .0020 | |
| 66,000 | | .0590 | | |
| 68,000 | | .0610 | | |
| 70,000 | | .0629 | | |
| 72,000 | | .0650 | | |
| 74,000 | | .0670 | | |
| 75,000 | | .0680 | | |
| 76,000 | | .0690 | | |
| 77,000 | | .0700 | | |
| 78,000 | | .0710 | | |
| 79,000 | | .0720 | | |
| 80,000 | 25,000 | .0730 | | |
| | 1,000 | | .0039 | |
| 81,000 | | .0745 | | |
| 82,000 | | .0756 | | |
| 83,000 | | .0768 | | |
| 84,000 | | .0780 | | |
| 85,000 | | .0790 | | |
| 86,000 | | .0801 | | |
| 87,000 | | .0815 | | |
| 88,000 | | .0829 | | |
| 89,000 | | .0844 | | |
| 90,000 | | .0858 | | |
| 91,000 | | .0871 | | |
| 92,000 | | .0887 | | |
| 93,000 | | .0905 | | |
| 94,000 | | .0921 | | |
| 95,000 | | .59 | | |
| 112,000 | 35,000 | 1.78 | | |
| 128,000 | 40,000 | 3.37 | | Elongation of 10″ sections: ″.75, ″.76, ″.77, ″.76, ″.79, ″.79, ″.79, ″.79. |
| 144,000 | 45,000 | 6.10 | | |
| 160,000 | | | | |
| 0 | 0 | | | Rested 2½ minutes. |
| 160,500 | 50,156 | | | Ultimate strength. |
| 0 | 0 | 18.16 | | = 22.7 per cent. |

Elongation of 10″ sections: 1″.70, 1″.88, 1″.94, 2″.14, 2″.19, 2″.40, 3″.02, 2″.84.
Diameter at fracture, 1″.53; area, 1.84 square inches.
Contraction of area, 43 per cent.
Appearance of fracture fibrous, cup-shaped.
Broke ¾″ outside gauged length, 12″ from face of holder jaws.

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No. 603.

Mark on bar, L 209.
Diameter, 2″.02; sectional area, 3.20 square inches.
Gauged length, 80″.

| Loads applied. | Pounds per square inch. | Elongation. | Permanent set. | Remarks. |
|---|---|---|---|---|
| *Pounds.* | | *Inch.* | *Inch.* | |
| 3,200 | 1,000 | 0. | | |
| 16,000 | 5,000 | .0125 | | |
| 32,000 | 10,000 | .0270 | | |
| | 1,000 | | .0018 | |
| 48,000 | 15,000 | .0416 | | |
| 64,000 | 20,000 | .0559 | | |
| | 1,000 | | .0019 | |
| 66,000 | | .0575 | | |
| 68,000 | | .0594 | | |
| 70,000 | | .0616 | | |
| 72,000 | | .0628 | | |
| 74,000 | | .0646 | | |
| 76,000 | | .0661 | | |
| 78,000 | | .0679 | | |
| 80,000 | 25,000 | .0696 | | |
| | 1,000 | | .0004 | |
| 81,000 | | .0700 | | |
| 82,000 | | .0712 | | |
| 83,000 | | .0721 | | |
| 84,000 | | .0731 | | |
| 85,000 | | .0740 | | |
| 86,000 | | .0750 | | |
| 87,000 | | .0760 | | |
| 88,000 | | .0770 | | |
| 89,000 | | .0781 | | |
| 90,000 | | .0792 | | |
| 91,000 | | .0809 | | |
| 92,000 | | .0820 | | |
| 93,000 | | .0834 | | |
| 94,000 | | .0856 | | |
| 95,000 | | .0876 | | |
| 96,000 | | .55 | | |
| 99,200 | 31,000 | .80 | | |
| 112,000 | 35,000 | 1.80 | | |
| 128,000 | 40,000 | 3.50 | | Elongation of 10″ sections: ″.80, ″.81, ″.81, ″.81, ″.80, ″.80, ″.79, ″.77. |
| 144,000 | 45,000 | 6.33 | | |
| 159,400 | | | | Rested 3 minutes. |
| 0 | 0 | | | Ultimate strength at time of fracture. |
| 159,800 | 49,937 | | | =22.6 per cent. |
| 143,000 | | | | |
| 0 | 0 | 18.05 | | |

Elongation of 10″ sections: 2″.31, 2″.59 (3″.60 at fracture), 2″.31, 2″.02, 1″.83, 1″.71, 1″.65.
Diameter at fracture, 1″.50; area, 177 square inches.
Contraction of area, 45 per cent.
Fracture fibrous, cup-shaped.

No. 604.

Mark on bar, L 210.
Diameter, 2″.02; sectional area, 3.20 square inches.
Gauged length, 80″.

| Loads applied. | Pounds per square inch. | Elongation. | Permanent set. | Remarks. |
|---|---|---|---|---|
| *Pounds.* | | *Inch.* | *Inch.* | |
| 3,200 | 1,000 | 0. | | |
| 16,000 | 5,000 | .0120 | | |
| 32,000 | 10,000 | .0265 | | |
| | 1,000 | | —.0004 | |
| 48,000 | 15,000 | .0410 | | |

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| Loads applied. | Pounds per square inch. | Elongation. | Permanent set. | Remarks. |
|---|---|---|---|---|
| *Pounds.* | | *Inch.* | *Inch.* | |
| 64,000 | 20,000 | .0552 | | |
| | 1,000 | | —.0020 | |
| 66,000 | | .0570 | | |
| 68,000 | | .0590 | | |
| 70,000 | | .0610 | | |
| 72,000 | | .0630 | | |
| 74,000 | | .0650 | | |
| 76,000 | | .0668 | | |
| 78,000 | | .0690 | | |
| 80,000 | 25,000 | .0710 | | |
| | 1,000 | | —.0010 | |
| 81,000 | | .0723 | | |
| 82,000 | | .0735 | | |
| 83,000 | | .0748 | | |
| 84,000 | | .0763 | | |
| 85,000 | | .0776 | | |
| 86,000 | | .0790 | | |
| 87,000 | | .0803 | | |
| 88,000 | | .0819 | | |
| 89,000 | | .0835 | | |
| 90,000 | | .0854 | | |
| 91,000 | | .0870 | | |
| 92,000 | | .0896 | | |
| 93,000 | | .0920 | | |
| 94,000 | | .0945 | | |
| 95,000 | | .0960 | | |
| 96,000 | | .765 | | |
| 99,200 | 31,000 | .86 | | |
| 112,000 | 35,000 | 1.70 | | |
| 128,000 | 40,000 | 3.35 | | Elongation of 10″ sections: ″.78, ″.76, ″.76, ″.76, ″.75, ″.75, ″.77, ″.79. |
| 144,000 | 45,000 | 6.07 | | |
| 160,400 | | | | |
| 0 | 0 | | | |
| 160,600 | 50,188 | | | Ultimate strength. |
| 0 | 0 | 15.96 | | =19.9 per cent. |

Elongation of 10″ sections: 1″.81, 1″.93, 1″.96, 1″.87, 1″.87, 1″.91, 2″.04, 2″.50.

Diameter at fracture, 1″.52; area, 1.82 square inches.

Contraction of area, 43 per cent.

Fracture fibrous, cup-shaped; broke 2″ outside of gauged section and 10″ from face of holder jaws.

*Tensile tests of single and double refined wrought iron (round bars).*

[Tabulated results.]

| Number of test. | Mark on bar. | Kind of iron. | Diameter of specimen. | Sectional area | Elastic limit. | Ultimate strength. | Elongation in 80 inches. | Contraction of area. | Appearance of fracture. |
|---|---|---|---|---|---|---|---|---|---|
| | | | *Inch.* | *Sq. in.* | *Lbs. per sq. in.* | *Lbs. per sq. in.* | *Per cent.* | *Per cent.* | |
| 593 | S 18... | Single refined | 2.01 | 3.17 | 24,600 | 49,680 | 19.5 | 32 | Fibrous; slightly granular. |
| 594 | S 19... | ....do | 2.01 | 3.17 | 25,870 | 49,338 | 18.3 | 38 | Fibrous. |
| 595 | S 20... | ....do | 2.01 | 3.17 | 24,920 | 48,864 | 18.4 | 37 | Fibrous, with some cinder at center. |
| 596 | S 218 . | Double refined | 2.01 | 3.17 | 24,610 | 50,631 | 20.4 | 41 | Fibrous. |
| 597 | S 219.. | ....do | 2.01 | 3.17 | | 50,915 | 25.5 | 44 | Fibrous; cup-shaped. |
| 598 | S 220.. | ....do | 2.01 | 3.17 | | 50,205 | 23.7 | 44 | Do. |
| 599 | L 8 ... | Single refined | 2.03 | 3.24 | | 51,667 | 22 | 36 | Fibrous, 70 per cent.; granular, 30 per cent. |
| 600 | L 9 ... | ....do | 2.02 | 3.20 | | 50,844 | 16.3 | 22 | Fibrous, 15 per cent.; granular, 85 per cent. |
| 601 | L 10 .. | ....do | 2.02 | 3.20 | | 53,062 | 21 | 40 | Fibrous, 95 per cent.; granular, 5 per cent. |
| 602 | L 208.. | Double refined | 2.02 | 3.20 | | 50,156 | 22.7 | 43 | Fibrous; cup-shaped. |
| 603 | L 209.. | ....do | 2.02 | 3.20 | | 49,937 | 22.6 | 45 | Do. |
| 604 | L 210 .. | ....do | 2.02 | 3.20 | | 50,188 | 19.9 | 43 | Do. |

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## No. 362.

### WROUGHT IRON, SINGLE ROLLED BAR.

*Supplementary test of No. 973.*

Mark on bar, L 5.

Bar tested a second time after about eight months' rest.

Original sectional area of bar, $5''.05 \times 1.''28 = 6.46$ square inches.

Rapid stretching began at 365,000 pounds = 56,500 pounds per square inch. Ultimate strength, 381,000 pounds = 58,980 pounds per square inch on original section.

Area of fracture, $4''.70 \times 1''.14 = 5.36$ square inches.

Contraction of area (from original size), 17 per cent.

Fracture: Granular, 70 per cent.; fibrous, 30 per cent.

10″ sections after second fracture, elongations of B: 2″.10, 1″.85, 1″.80, 1″.80, 1″.86, 1″.82 A.

Second fracture occurred 16″ from the first fracture.

Bar heated slightly hotter than cherry-red, and allowed to cool in the open air. About 12″ to 15″ of the ends were not heated.

Average sectional area of bar, $4''.75 \times 1''.17 = 5.56$ square inches.

Gauged length, 50″.

| Loads applied. | Pounds per square inch on reduced section. | Elongation. | Permanent set. | Remarks. |
|---|---|---|---|---|
| *Pounds.* | | *Inch.* | *Inch.* | |
| 5,560 | 1,000 | 0. | | |
| 27,800 | 5,000 | .0080 | | |
| 55,600 | 10,000 | .0188 | | |
| | 1,000 | | .0008 | |
| 83,400 | 15,000 | .0292 | | |
| 111,200 | 20,000 | .0401 | | |
| | 1,000 | | .0030 | |
| 115,000 | | .0421 | | |
| 120,000 | | .0448 | | |
| 125,000 | | .0470 | | |
| 130,000 | | .0498 | | |
| 135,000 | | .0525 | | |
| 140,000 | 26,080 | .0560 | | Elastic limit. |
| 145,000 | | .0780 | | |
| 150,000 | | .1770 | | |
| 234,000 | 42,090 | | | Ultimate strength. |
| | 21,670 | | | Elastic limit on original section. |
| | 36,220 | | | Ultimate strength on original section. |

Broke 17½″ from end A. Fracture, fibrous, 100 per cent.

This fracture took place near the end of the annealed section of the bar.

Stretch of bar about 33 per cent. from original length.

Bar tested again, breaking with 269,000 pounds = 48,380 pounds per square inch = 41,640 pounds per square inch on original section. Fracture, fibrous, 100 per cent.

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*Supplementary tests of single and double rolled wrought-iron bars.*

No. 384.

Mark on bar, L 2.

Bar retested after ten months' rest.

Present sectional area (average section), $2''.84 \times ''.94 = 2.67$ square inches.

Gauged length, 50″.

| Loads applied. | Pounds per square inch. | Elongation. | Permanent set. | Remarks. |
|---|---|---|---|---|
| *Pounds.* | | *Inch.* | *Inch.* | |
| 2,670 | 1,000 | 0. | | |
| 13,350 | 5,000 | .0178 | | |
| 26,700 | 10,000 | .0175 | | |
| | 5,000 | | .0005 | |
| 40,050 | 15,000 | .0275 | | |
| 53,400 | 20,000 | .0365 | | |
| | 1,000 | | .0008 | |
| 66,750 | 25,000 | .0460 | | |
| 80,100 | 30,000 | .0558 | | |
| | 1,000 | | .0010 | |
| 85,000 | | .0590 | | |
| 90,000 | | .0628 | | |
| 95,000 | | .0660 | | |
| 100,000 | | .0695 | | |
| 106,800 | 40,000 | .0742 | | |
| | 1,000 | | .0011 | |
| 110,000 | | .0768 | | |
| 115,000 | | .0800 | | |
| 116,000 | | .0808 | | |
| 117,000 | | .0816 | | |
| 118,000 | | .0825 | | |
| 119,000 | | .0830 | | |
| 120,000 | | .0838 | | |
| 121,000 | | .0846 | | |
| 122,000 | | .0852 | | |
| 123,000 | | .0858 | | |
| 124,000 | | .0866 | | |
| 125,000 | | .0875 | | |
| 126,000 | | .0880 | | |
| 127,000 | | .0888 | | |
| 128,000 | | .0895 | | |
| 129,000 | | .0905 | | |
| 130,000 | | .0910 | | |
| 131,000 | | .0918 | | |
| 132,000 | | .0922 | | |
| 133,000 | | .0930 | | |
| 134,000 | | .0938 | | |
| 135,000 | | .0946 | | |
| 136,000 | | .0955 | | |
| 137,000 | | .0960 | | |
| 138,000 | | .0968 | | |
| 139,000 | | .0975 | | |
| 140,000 | | .0984 | | |
| 141,000 | | .0990 | | |
| 142,000 | | .1000 | | |
| 143,000 | | .1008 | | |
| 144,000 | | .1015 | | |
| 145,000 | | .1022 | | |
| 146,000 | | .1030 | | |
| 147,000 | | .1038 | | |
| 148,000 | | .1048 | | |
| 149,000 | | .1055 | | |
| 150,000 | | .1062 | | |
| 151,000 | | .1072 | | |
| 152,000 | | .1080 | | |
| 153,000 | | .1090 | | |
| 154,000 | | .1100 | | |
| 155,000 | | .1108 | | |
| 156,000 | | .1118 | | |
| 157,000 | | .1128 | | |
| 158,000 | | .1138 | | |
| 159,000 | | .1148 | | |
| 160,000 | | .1158 | | |
| 161,000 | | .1168 | | |
| 162,000 | | .1178 | | |
| 163,000 | | .1188 | | |
| 164,000 | | .1200 | | |

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| Loads applied. | Pounds per square inch. | Elongation. | Permanent set. | Remarks. |
|---|---|---|---|---|
| *Pounds.* | | *Inch.* | *Inch.* | |
| 165,000 | 61,800 | .1210 | | Elastic limit on original area, 53,920 pounds per square inch. |
| 166,000 | | .1225 | | |
| 167,000 | | .1238 | | |
| 168,000 | | .1250 | | |
| 169,000 | | .1262 | | |
| 170,000 | | .1278 | | |
| 171,000 | | .1290 | | |
| 172,000 | | .1308 | | |
| 173,000 | | .1322 | | |
| 174,000 | | .1340 | | |
| 175,000 | | .1358 | | |
| 176,000 | | .1378 | | |
| 177,000 | | .1400 | | |
| 178,000 | | .1428 | | |
| 179,000 | | .1455 | | |
| 180,000 | | .1490 | | Ultimate strength on original area 63,130 pounds per square inch. |
| 193,200 | 72,360 | | | |
| 0 | 0 | 3.40 | | = 6.8 per cent. |

Elongation of 10″ sections from original lengths: 2″.41, 2″.72, 2″.70 ☼, 2″.47, 2″.30, 2″.20, 2″.01.

Area at fracture, 2″.72 × ″.88 = 2.39 square inches.
Contraction of area from original section, 21.9 per cent.
Granular fracture.

No. 385.

The longer fractured end of bar No. 384 was now taken and heated over an open fire till dull red in daylight, and then cooled in open air.
Present sectional area, 2″.80 × ″.92 = 2.58 square inches.
Gauged length, 20″.

| Loads applied. | Pounds per square inch. | Elongation. | Permanent set. | Remarks. |
|---|---|---|---|---|
| *Pounds.* | | *Inch.* | *Inch.* | |
| 2,580 | 1,000 | 0. | | |
| 12,900 | 5,000 | .0028 | | |
| 25,800 | 10,000 | .0062 | | |
| 38,700 | 15,000 | .0100 | | |
| 51,600 | 20,000 | .0140 | | |
| | 1,000 | | .0008 | |
| 55,000 | | .0150 | | |
| 58,000 | | .0160 | | |
| 61,000 | | .0170 | | |
| 64,000 | | .0185 | | |
| 67,000 | | .0191 | | |
| 70,000 | 27,130 | .0200 | | Elastic limit, 22,880 pounds per square inch on original section. |
| 73,000 | | .0221 | | |
| 76,000 | | .0358 | | |
| 79,000 | | {.0595 / .0688} | | After sustaining load 3 minutes. |
| 82,000 | | .0750 | | |
| 85,000 | | .147 | | |
| 126,200 | 48,910 | | | Ultimate strength 41,240 pounds per square inch on original section. |
| 0 | 0 | 1.52 | | =7.6 per cent. |

Elongation of original 10″ sections: 3″.60, 3″.08 ☼, 2″.91.

Area at fracture, 2″.52 × ″.80 = 2.02 square inches.
Contraction of area (from original section), 34 per cent.
Fracture, dull fibrous.

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No. 386.

*Supplementary test of bar* L 201.

Rested since original test ten months.
Present sectional area (average, 2″.87 × ″.95 = 2″.73 square inches.
Gauged length, 50″.

| Loads applied. | Pounds per square inch. | Elongation. | Permanent set. | Remarks. |
|---|---|---|---|---|
| *Pounds.* | | *Inch.* | *Inch.* | |
| 2,730 | 1,000 | 0. | | |
| 13,650 | 5,000 | .0080 | | |
| 27,300 | 10,000 | .0180 | | |
| 54,600 | 20,000 | .0370 | | |
| 81,900 | 30,000 | .0560 | | |
| 109,200 | 40,000 | .0748 | | |
| | 1,000 | | .0006 | |
| 122,850 | 45,000 | .0840 | | |
| 136,500 | 50,000 | .0940 | | |
| | 1,000 | | .0011 | |
| 138,000 | | .0955 | | |
| 140,000 | | .0968 | | |
| 142,000 | | .0982 | | |
| 144,000 | | .0999 | | |
| 146,000 | | .1013 | | |
| 148,000 | | .1030 | | |
| 150,000 | | .1046 | | |
| 151,000 | | .1058 | | |
| 152,000 | | .1064 | | |
| 153,000 | | .1072 | | |
| 154,000 | | .1081 | | |
| 155,000 | | .1090 | | |
| 156,000 | | .1100 | | |
| 157,000 | | .1110 | | |
| 158,000 | | .1120 | | |
| 159,000 | | .1128 | | |
| 160,000 | | .1138 | | |
| 161,000 | | .1150 | | |
| 162,000 | | .1160 | | |
| 163,000 | | .1170 | | |
| 164,000 | | .1180 | | |
| 165,000 | 60,440 | .1192 | | Elastic limit, 53,920 pounds per square inch on original section. |
| 166,000 | | .1206 | | |
| 167,000 | | .1218 | | |
| 168,000 | | .1230 | | |
| 169,000 | | .1245 | | |
| 170,000 | | .1258 | | |
| 171,000 | | .1272 | | |
| 172,000 | | .1288 | | |
| 173,000 | | .1305 | | |
| 174,000 | | .1320 | | |
| 175,000 | | .1340 | | |
| 176,000 | | .1360 | | |
| 178,000 | | .1408 | | |
| 180,000 | | .1480 | | |
| 182,000 | | .155 | | |
| 184,000 | | .535 | | |
| 193,000 | 70,696 | | | Ultimate strength, 63,070 pounds per square inch on original area. |
| 0 | 0 | 2.13 | | = 4.3 per cent. |

Elongation of 10″ sections from original lengths: 8″.28 ✱, 1″.99, 1″.93, 1″.98, 1″.95, 2″.

Area at fracture, 2″.76 × ″.89 = 2.46 square inches.

Contraction of area (from original area), 19.6 per cent.

Fracture: Granular, 90 per cent.; with fibrous spot, 10 per cent.

The longer fractured end of bar No. 386 was now taken and heated over an open fire till it would melt solder rubbed on its surface; temperature called 370°, allowed to cool in the open air.

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No. 387.

L 201, continued.

Present sectional area, 2″.83 × ″.92 = 2.6 square inches.

Gauged length, 20″.

| Loads applied. | Pounds per square inch. | Elongation. | Permanent set. | Remarks. |
|---|---|---|---|---|
| *Pounds.* | | *Inch.* | *Inch.* | |
| 2,600 | 1,000 | 0. | | |
| 13,000 | 5,000 | .0030 | | |
| 26,000 | 10,000 | .0068 | | |
| 2,600 | 1,000 | 0. | | |
| 13,000 | 5,000 | .0030 | | |
| 26,000 | 10,000 | .0068 | | |
| 39,000 | 15,000 | .0108 | | |
| 52,000 | 20,000 | .0145 | | |
| | 1,000 | | 0. | |
| 55,000 | | .0155 | | |
| 58,000 | | .0162 | | |
| 61,000 | | .0171 | | |
| 64,000 | | .0180 | | |
| 67,000 | | .0190 | | |
| 70,000 | | .0200 | | |
| 73,000 | | .0208 | | |
| 76,000 | | .0215 | | |
| 79,000 | | .0225 | | |
| 82,000 | | .0235 | | |
| 85,000 | | .0241 | | |
| 88,000 | | .0250 | | |
| 91,000 | | .0260 | | |
| 94,000 | | .0270 | | |
| 97,000 | | .0280 | | |
| 100,000 | | .0288 | | |
| 103,000 | | .0295 | | |
| 106,000 | | .0305 | | |
| 109,000 | | .0312 | | |
| 112,000 | | .0320 | | |
| 115,000 | | .0330 | | |
| 118,000 | | .0339 | | |
| 121,000 | | .0348 | | |
| 124,000 | | .0356 | | |
| 127,000 | | .0365 | | |
| 130,000 | | .0370 | | |
| 133,000 | | .0380 | | |
| 136,000 | | .0388 | | |
| 139,000 | | .0398 | | |
| 142,000 | | .0408 | | |
| 145,000 | | .0415 | | |
| 148,000 | | .0422 | | |
| 151,000 | | .0432 | | |
| 154,000 | | .0442 | | |
| 157,000 | | .0452 | | |
| 160,000 | | .0462 | | |
| 163,000 | | .0470 | | |
| 166,000 | | .0480 | | |
| 169,000 | | .0490 | | |
| 176,000 | 67,700 | | | Ultimate strength, 57,520 pounds per square inch on original section. |
| 0 | 0 | 0 | | |

Area at fracture, 2″.56 × ″.78 = 2 square inches.

Contraction of area (from original section), 34.6 per cent.

Fracture fibrous, 60 per cent.; interspersed with granular spots, 40 per cent.

Broke outside 20″, gauged length.

During this test the bar stretched in the vicinity of the fracture and slightly at the opposite end, about ″.07 in ″.10.

Tested again March 1, 1882.

Ultimate strength, 191,000 pounds = 62,420 pounds per square inch on original section.

Fracture: Fibrous, 60 per cent.; granular, 40 per cent.

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*Supplementary test of bar* L 203.

Rested nine months since original test.
Present sectional area, 2″.84 × ″.94 = 2″.67 square inches.
Gauged length, .50″.

No. 388.

| Loads applied. | Pounds per square inch. | Elongation. | Permanent set. | Remarks. |
|---|---|---|---|---|
| *Pounds.* | | *Inch.* | *Inch.* | |
| 2,670 | 1,000 | 0. | ..... | |
| 13,350 | 5,000 | .0075 | ..... | |
| 26,700 | 10,000 | .0170 | ..... | |
| 53,400 | 20,000 | .0355 | ..... | |
| 80,100 | 30,000 | .0540 | ..... | |
| 106,800 | 40,000 | .0725 | ..... | |
| 133,500 | 50,000 | .0910 | ..... | |
| ..... | 1,000 | ..... | .0006 | |
| 140,000 | ..... | .0960 | ..... | |
| 150,000 | ..... | .1032 | ..... | |
| 152,000 | ..... | .1050 | ..... | |
| 154,000 | ..... | .1068 | ..... | |
| 156,000 | ..... | .1085 | ..... | |
| 158,000 | ..... | .1102 | ..... | |
| 160,000 | ..... | .1120 | ..... | |
| 161,000 | ..... | .1128 | ..... | |
| 162,000 | ..... | .1138 | ..... | |
| 163,000 | ..... | .1148 | ..... | |
| 164,000 | ..... | .1159 | ..... | |
| 165,000 | ..... | .1170 | ..... | |
| 166,000 | ..... | .1180 | ..... | |
| 167,000 | ..... | .1190 | ..... | |
| 168,000 | ..... | .1200 | ..... | |
| 169,000 | ..... | .1210 | ..... | |
| 170,000 | ..... | .1220 | ..... | |
| 171,000 | 64,040 | .1232 | ..... | Elastic limit, 55,880 pounds per square inch on original section. |
| 172,000 | ..... | .1248 | ..... | |
| 173,000 | ..... | .1262 | ..... | |
| 174,000 | ..... | .1278 | ..... | |
| 175,000 | ..... | .1288 | ..... | |
| 176,000 | ..... | .1300 | ..... | |
| 177,000 | ..... | .1320 | ..... | |
| 178,000 | ..... | .1338 | ..... | |
| 179,000 | ..... | .1352 | ..... | |
| 180,000 | ..... | .1375 | ..... | |
| 181,000 | ..... | .1395 | ..... | |
| 182,000 | ..... | .1420 | ..... | |
| 183,000 | ..... | .1446 | ..... | |
| 184,000 | ..... | .1478 | ..... | |
| 185,000 | ..... | .1512 | ..... | |
| 186,000 | ..... | .1582 | ..... | |
| 187,000 | ..... | .1660 | ..... | |
| 193,900 | 72,620 | ..... | ..... | Ultimate strength, 63,360 pounds per square inch on original section. |
| 0 | 0 | 2.10 | ..... | = 4.2 per cent. |

Elongation of original 10″ sections: 2″.12, 2″.30 , 2″.11, 2″.06, 1″.98, 2″:06.
Area at fracture, 2″.75 × ″.89 = 2.45 square inches.
Contraction of area from original section, 19.9 per cent.
Fracture: Granular, 70 per cent.; fibrous, 30 per cent.

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*Tabulation of tensile tests of wrought-iron bars, showing original strength and strength after the bars had rested, also strength after annealing.*

| Number of test. | Condition of bar when tested. | Size of bar when tested. | | | Strains on original section. | | Strains on reduced section. | | Uniform elongation from original length. | Contraction of area from original section. | Appearance of fracture. | Remarks. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Width. | Thick. | Sectional area. | Elastic limit. | Ultimate strength. | Elastic limit. | Ultimate strength. | | | | |
| | | *Inch.* | *Inch.* | *Sq. in.* | *Lbs. per sq. in.* | *Lbs. per sq. in.* | *Lbs. per sq. in.* | *Lbs. per sq. in.* | *Pr. ct.* | *Pr. ct.* | | |
| 993 | Original | 3.05 | 1 | 3.05 | 29,500 | 51,150 | ..... | ..... | 21 | 31.5 | Fine fibrous | |
| | Rested four months since original test. | ..... | ..... | ..... | ..... | 60,000 | ..... | ..... | 24 | ..... | Fibrous, 90 per cent.; granular 10 per cent. | |
| 994 | Original | 3.05 | 1 | 3.05 | 28,500 | 51,110 | ..... | ..... | 21 | 36.1 | Fine fibrous | |
| | Rested four and two-thirds months | ..... | ..... | ..... | 53,440 | 61,960 | ..... | ..... | 25 | 33.8 | Fibrous, 92 per cent.; granular, 8 per cent. | |
| 981 | Original | 3.05 | 1.01 | 3.08 | 28,000 | 50,390 | ..... | ..... | 14 | 35.1 | Fibrous | |
| | Rested five months | ..... | ..... | ..... | ..... | 60,390 | ..... | ..... | 20 | 21.8 | Granular, 70 per cent.; fibrous, 30 per cent. | |
| 973 | Original | 5.05 | 1.28 | 6.46 | 27,500 | 50,500 | ..... | ..... | 13 | 24.2 | Fibrous, 95 per cent.; granular, 5 per cent. | |
| | Rested eight months | ..... | ..... | ..... | 56,500 | 58,980 | ..... | ..... | 18 | 17 | Fibrous, 30 per cent.; granular, 70 per cent. | |
| | Heated cherry-red and cooled in open air. | 4.75 | 1.17 | 5.56 | 21,670 | {36,220 / 41,640} | 26,080 | {42,090 / 48,380} | 33 | ..... | Fibrous | Broke at end of annealed section. |
| 774 | Original | 3.03 | 1.01 | 3.06 | 29,500 | 53,630 | ..... | ..... | 16 | 36 | Fibrous, 92 per cent.; granular, 8 per cent | |
| 384 | Rested ten months | 2.84 | .94 | 2.67 | 53,920 | 63,130 | 61,800 | 72,360 | 23 | 21.9 | Granular | |
| 385 | Heated dull red and cooled in open air. | 2.80 | .92 | 2.58 | 23,800 | 41,240 | 27,130 | 48,910 | 32 | 34 | Dull fibrous | |
| 777 | Original | 3.03 | 1.01 | 3.06 | 29,000 | 53,560 | ..... | ..... | 15 | 37.9 | Fibrous | |
| 386 | Rested ten months | 2.87 | .95 | 2.73 | 53,920 | 63,070 | 60,440 | 70,696 | 19 | 19.6 | Fibrous, 10 per cent.; granular, 90 per cent | |
| 387 | Heated to 370° and cooled in open air. | 2.83 | .92 | ..... | 57,520 | 57,520 | 67,700 | 67,700 | 19 | 34.6 | Fibrous, 60 per cent.; granular, 40 per cent | |
| | Rested fifteen days after third test | ..... | ..... | ..... | ..... | 62,420 | ..... | ..... | ..... | ..... | do | |
| 971 | Original | 3.03 | 1.01 | 3.06 | 32,500 | 53,500 | ..... | ..... | 16 | 27.5 | Fibrous | |
| 388 | Rested nine months | 2.84 | .94 | 2.67 | 55,880 | 63,360 | 64,040 | 72,620 | 21 | 19.9 | Fibrous, 30 per cent.; granular, 70 per cent. | |
| 389 | Rested nine months | 2.84 | .92 | 2.61 | ..... | 66,010 | ..... | 77,400 | 21 | 19.9 | Fine granular | |

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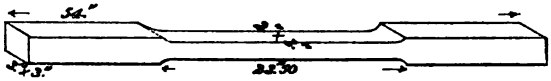
*Tensile test of wrought iron for 3″ × 3″ compression tests.*

No. 321.

FORM OF SPECIMEN.



Gauged length, 20″.
Sectional area, 6 square inches.

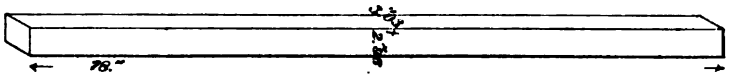
| Loads applied. | Pounds per square inch. | Elongation. | Permanent set. | Remarks. |
|---|---|---|---|---|
| *Pounds.* | | *Inch.* | *Inch.* | |
| 6,000 | 1,000 | 0. | | |
| 30,000 | 5,000 | .0030 | | |
| 60,000 | 10,000 | .0070 | | |
| | 1,000 | | 0. | |
| 90,000 | 15,000 | .0108 | | |
| 108,000 | 18,000 | .0130 | | |
| 120,000 | 20,000 | .0150 | | |
| | 1,000 | | .0009 | |
| 125,000 | | .0160 | | |
| 130,000 | | .0170 | | |
| 132,000 | | .0176 | | |
| 134,000 | | .0181 | | |
| 136,000 | | .0185 | | |
| 138,000 | | .0189 | | |
| 140,000 | | .0192 | | |
| 142,000 | | .0199 | | |
| 144,000 | | .0205 | | |
| 146 000 | 24,330 | .0210 | | Elastic limit. |
| 148,000 | | .0219 | | |
| 150,000 | 25,000 | .0228 | | |
| | 1,000 | | .0050 | |
| 152,000 | | .0260 | | |
| 154,000 | | .0280 | | |
| 156,000 | | .0420 | | Still elongates under this load. |
| 308,400 | 51,600 | | | Ultimate strength. |
| 0 | 0 | 4.31 | | = 31.5 per cent. |

Elongation of 1″ sections: ″.22, ″.21, ″.20, ″.23, ″.26, ″.36, ″.46 ✠, ″.28, ″.22, ″.19, ″.18, ″.18, ″.18, ″.17, ″.18, ″.17, ″.17, ″.17, ″.17, 17″, ″.17.

Area at fracture, 2″.47 × 1″.67 = 4.12 square inches.
Contraction of area, 31.3 per cent.
Appearance of fracture: Fibrous, 60 per cent.; granular, 40 per cent.
Light-colored fracture.

No. 322.

*Tensile test of wrought iron for 3″ × 3″ compression tests.*



Sectional area, 8.97 square inches.
Gauged length, 20″.

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| Loads applied. | Pounds per square inch. | Elongation. | Permanent set. | Remarks. |
|---|---|---|---|---|
| *Pounds.* | | *Inch.* | *Inch.* | |
| 8,970 | 1,000 | 0. | ..... | |
| 44,850 | 5,000 | .0030 | ..... | |
| 89,700 | 10,000 | .0071 | ..... | |
| ..... | 1,000 | ..... | .0002 | |
| 134,550 | 15,000 | .0121 | ..... | |
| 161,460 | 18,000 | .0155 | ..... | |
| 179,400 | 20,000 | .0178 | ..... | |
| ..... | 1,000 | ..... | .0032 | |
| 180,000 | ..... | .0182 | ..... | Rested 10 minutes. |
| 182,000 | ..... | .0188 | ..... | |
| 184,000 | ..... | .0188 | ..... | |
| 186,000 | ..... | .0190 | ..... | |
| 188,000 | ..... | .0191 | ..... | |
| 190,000 | ..... | .0192 | ..... | |
| 192,000 | ..... | .0195 | ..... | |
| 194,000 | ..... | .0198 | ..... | |
| 196,000 | ..... | .0200 | ..... | |
| 198,000 | ..... | .0205 | ..... | |
| 200,000 | ..... | .0208 | ..... | |
| 202,000 | ..... | .0212 | ..... | |
| 204,000 | ..... | .0219 | ..... | |
| 206,000 | ..... | .0222 | ..... | |
| 208,000 | ..... | .0226 | ..... | |
| 210,000 | ..... | .0228 | ..... | |
| 212,000 | ..... | .0231 | ..... | |
| 214,000 | ..... | .0235 | ..... | |
| 216,000 | ..... | .0240 | ..... | |
| 218,000 | ..... | .0248 | ..... | |
| 220,000 | ..... | .0251 | ..... | |
| 222,000 | ..... | .0259 | ..... | |
| 224,250 | 25,000 | .0268 | ..... | |
| ..... | 1,000 | ..... | .0086 | |
| 226,000 | ..... | .0280 | ..... | |
| 228,000 | ..... | .0290 | ..... | |
| 230,000 | 25,640 | .0300 | ..... | Elastic limit. |
| 232,000 | ..... | .0325 | ..... | |
| 234,000 | ..... | .0490 | ..... | |
| 236,000 | ..... | .0860 | ..... | |
| 452,500 | 50,446 | ..... | ..... | Ultimate strength. |
| 0 | 0 | 4.30 | ..... | = 21.5 per cent. |

Elongation of 1″ sections: ″.20, ″.20, ″.21, ″.22, ″.22, ″.22, ″.22, ″.22, ″.21, ″.22, ″.22, ″.22, ″.22, ″.23, ″.23, ″.24, ″.24, ″.23, ″.23, ″.24.

Area at fracture, 2″.56 × 2″.50 = 6.4 square inches.

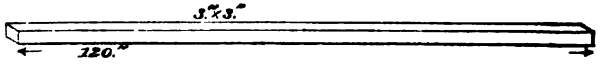
Contraction of area, 28.6 per cent.

Broke 4″ from face of holder jaws.

Appearance: Fibrous, 40 per cent.; granular, 60 per cent.

## No. 323.

*Tensile test of wrought iron for 3″ × 3″ compression tests.*




Sectional area, 9 square inches.

Gauged length, 50″.

| Loads applied. | Pounds per square inch. | Elongation. | Permanent set. | Remarks. |
|---|---|---|---|---|
| *Pounds.* | | *Inch.* | *Inch.* | |
| 2,000 | 1,000 | 0. | ..... | |
| 45,000 | 5,000 | .0078 | ..... | |
| 90,000 | 10,000 | .0172 | ..... | |
| ..... | 1,000 | ..... | .0002 | |
| 135,000 | 15,000 | .0270 | ..... | |
| 162,000 | 18,000 | .0335 | ..... | |
| 180,000 | 20,000 | .0400 | ..... | |

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| Loads applied. | Pounds per square inch. | Elongation. | Permanent set. | Remarks. |
|---|---|---|---|---|
| *Pounds.* | | *Inch.* | *Inch.* | |
| ..... | 1,000 | ..... | .0062 | |
| 185,000 | ..... | .0459 | ..... | |
| 190,000 | ..... | .0505 | ..... | |
| 192,000 | ..... | .0540 | ..... | |
| 194,000 | ..... | .0555 | ..... | |
| 196,000 | ..... | .0570 | ..... | |
| 198,000 | ..... | .0598 | ..... | |
| 200,000 | ..... | .0650 | ..... | |
| 202,000 | ..... | .0712 | ..... | |
| 204,000 | ..... | .0870 | ..... | |
| 206,000 | ..... | .128 | ..... | |
| ..... | 1,000 | ..... | ..... | Rested one hour. |
| 446,000 | ..... | ..... | ..... | Ultimate strength. |
| 0 | 0 | 11.36 | ..... | = 22.7 per cent. |

Elongation of 5″ sections: 1″.11, 1″.20, 1″.30, 1″.20, 1″.19, 1″.21, 1″.11, 1″.04, 1″.02, 1″.02.

Area at fracture, 2″.45 × 2″.45 = 6 square inches.

Contraction of area, 33.3 per cent.

Broke at face of holder jaws.

Appearance: Fibrous, 45 per cent.; granular, 55 per cent.

## No. 390.

*Tensile test of 3″ × 3″ wrought iron, bar branded.*

STIRLING BEST—BEST REFINED.

Total length of bar, about 78″.

Gauged length, 24″.

Sectional area, 3″.02 × 3″.02 = 9.12 square inches.

| Loads applied. | Pounds per square inch. | Elongation. | Permanent set. | Remarks. |
|---|---|---|---|---|
| *Pounds.* | | *Inch.* | *Inch.* | |
| 9,120 | 1,000 | 0. | ..... | |
| 45,600 | 5,000 | .0030 | ..... | |
| 91,200 | 10,000 | .0075 | ..... | |
| ..... | 1,000 | ..... | 0. | |
| 136,800 | 15,000 | .0120 | ..... | |
| 182,400 | 20,000 | .0161 | ..... | |
| ..... | 1,000 | ..... | .0005 | |
| 188,000 | ..... | .0170 | ..... | |
| 193,000 | ..... | .0178 | ..... | |
| 198,000 | ..... | .0182 | ..... | |
| 203,000 | ..... | .0190 | ..... | |
| 208,000 | ..... | .0195 | ..... | |
| 213,000 | ..... | .0200 | ..... | |
| 218,000 | ..... | .0210 | ..... | |
| 223,000 | ..... | .0215 | ..... | |
| 228,000 | 25,000 | .0225 | ..... | |
| ..... | 1,000 | ..... | .0020 | |
| 230,000 | ..... | .0231 | ..... | |
| 232,000 | ..... | .0238 | ..... | |
| 234,000 | ..... | .0241 | ..... | |
| 236,000 | ..... | .0245 | ..... | |
| 238,000 | ..... | .0251 | ..... | |
| 240,000 | ..... | .0260 | ..... | |
| 242,000 | ..... | .0262 | ..... | |
| 244,000 | ..... | .0266 | ..... | |
| 246,000 | 26,970 | .0270 | ..... | Elastic limit. |
| 248,000 | ..... | .0278 | ..... | |
| 250,000 | ..... | .0286 | ..... | |
| 252,000 | ..... | .0440 | ..... | |
| 254,000 | ..... | .1100 | ..... | |
| 260,000 | ..... | .136 | ..... | |
| 270,000 | ..... | .192 | ..... | |
| 449,000 | 49,230 | ..... | ..... | Ultimate strength. |
| 0 | 0 | 3.15 | ..... | = 13.1 per cent. |

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Elongation of inch sections after fracture of bar: ″.15, ″.14, ″.14, ″.14, ″.13, ″.13, ″.13, ″.13, ″.13, ″.13, ″.13, ″.14, ″.15, ″.13, ″.13, ″.13, ″.13, ″.12, ″.13, ″.13, ″.13, ″.13, ″.13, ″.13, ″.14, ″.13.

Fractured about 1 inch inside the section covered by holder jaws.

Area at fracture, 2″.83×2″.78=7.87 square inch.

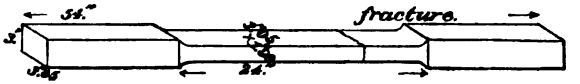
Contraction of area, 13.7 per cent.

Appearance of fracture: Granular, 95 per cent.; fibrous, 5 per cent.

No. 395.

*Tensile test of 3″×3″ wrought-iron bar.*

FORM OF SPECIMEN.




Sectional area, 3″.05×1″.99=6.07 square inches.

Gauged length, 24″.

| Loads applied. | Pounds per square inch. | Elongation. | Permanent set. | Remarks. |
|---|---|---|---|---|
| *Pounds.* | | *Inch.* | *Inch.* | |
| 6,070 | 1,000 | 0. | | |
| 30,350 | 5,000 | .0031 | | |
| 60,700 | 10,000 | .0078 | | |
| | 1,000 | | .0002 | |
| 91,050 | 15,000 | .0128 | | |
| 121,400 | 20,000 | .0185 | | |
| | 1,000 | | .0020 | |
| 124,000 | | .0192 | | |
| 127,000 | | .0200 | | |
| 130,000 | | .0210 | | |
| 133,000 | | .0220 | | |
| 136,000 | | .0230 | | |
| 139,000 | 22,900 | .0240 | | Elastic limit. |
| 142,000 | | .0258 | | |
| 145,000 | | .0282 | | |
| 148,000 | | .0310 | | |
| 151,750 | 25,000 | .0400 | | |
| | 1,000 | | .0200 | |
| 154,000 | | .0490 | | |
| 157,000 | | .0560 | | |
| 160,000 | | .0720 | | |
| 163,000 | | .098 | | |
| 296,000 | 48,764 | | | Ultimate strength. |
| 0 | 0 | 4.85 | | =20.2 per cent. |

Elongation of 1″ sections after fracture: ″.16, ″.20, ″.22, ″.21, ″.29✸, ″.21, ″.23, ″.21, ″.20, ″.20, ″.20, ″.20, ″.22, ″.22, ″.26, ″.23, ″.23, ″.22, ″.20, ″.21, ″.20, ″.18, ″.18, ″.15.

Area of fracture, 2″.78×1″.83=5.09 square inches.

Contraction of area, 16.1 per cent.

Broke 6″ from neck, with granular fracture varying in degree of coarseness, fibrous about 5 per cent.

Seams in iron.

No. 396.

Off same bar as No. 395.

Tested full size as it came from the rolls.

Total length, 126″.75.

Gauged length, 80″.

Sectional area, 3″.03×3″.02=9.15 square inches.



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| Loads applied. | Pounds per square inch. | Elongation. | Permanent set. | Remarks. |
|---|---|---|---|---|
| *Pounds.* | | *Inch.* | *Inch.* | |
| 9,150 | 1,000 | 0. | | |
| 45,750 | 5,000 | .0120 | | |
| 91,500 | 10,000 | .0275 | | |
| | 1,000 | | .0005 | |
| 137,250 | 15,000 | .0430 | | |
| 183,000 | 20,000 | .0020 | | |
| | 1,000 | | .0050 | |
| 188,000 | | .0650 | | |
| 193,000 | | .0685 | | |
| 198,000 | | .0710 | | |
| 203,000 | | .0740 | | |
| 208,000 | 22,730 | .0780 | | Elastic limit. |
| 213,000 | | .0830 | | |
| 218,000 | | .0908 | | |
| 223,000 | | .1065 | | |
| 228,750 | 25,000 | .1580 | | |
| | 1,000 | | .0858 | |
| 233,000 | | .2060 | | |
| 238,000 | | .347 | | |
| 408,500 | 44,645 | | | Ultimate strength. |
| 0 | 0 | 7.62 | | =9.5 per cent. |

Elongation in 5″ sections after fracture of bar: ″.50, ″.50, ″.47 ″.55, ″.48, ″.51, ″.49, ″.46, ″.46, 47, ″.46, ″.48, ″.47, ″.46, ″.48, ″.4.

No. 396.

Area at fracture, 2″.87 × 2″.87 = 8.24 square inches.

Contraction of area, 10 per cent.

Broke 42″.50 from end. Appearance granular. Similar to fracture of end No. 395.

Eight cracks along one surface developed by test. Maximum crack, 3″ long × ½″ deep.

Small piece, about 1 ounce weight, flew out at point of fracture when specimen broke.

WROUGHT IRON—ROUND BARS.

*Tests to determine the modulus of elasticity in the same bars for strains of tension and compression.*

Bars of Phoenix and Pencoyd iron, cut in two at middle; one end strained by tension, and one end by compression.

These bars were taken from the same lot of iron that was used for the transverse strength of pins. (See report of tests, 1881.

No. 333.

PHŒNIX IRON—ROUGH BAR.

2½″ diameter, turned down to about 2″ diameter.

Actual diameter, 2.″003.

Sectional area, 3.142 square inches.

Gauged length, 30″.

TENSILE LOADS.

| Loads applied. | Pounds per square inch. | Elongation. | Permanent set. | Remarks. |
|---|---|---|---|---|
| *Pounds.* | | *Inch.* | *Inch.* | |
| 3,142 | 1,000 | 0. | | |
| 15,710 | 5,000 | .0040 | | |
| 25,136 | 8,000 | .0070 | | |
| 31,420 | 10,000 | .0090 | | |
| | 1,000 | | 0 | |
| 37,704 | 12,000 | .0114 | | |
| 47,130 | 15,000 | .0140 | | E = 30,000,000. |
| | 1,000 | | 0 | |

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COMPRESSION LOADS.

| Pounds per square inch. | Compression. | Permanent set. | Remarks. |
|---|---|---|---|
| | *Inch.* | *Inch.* | |
| 1,000 | 0. | ..... | |
| 5,000 | .0050 | ..... | |
| 8,000 | .0076 | ..... | |
| 10,000 | .0096 | ..... | |
| 1,000 | ..... | .0005 | |
| 12,000 | .0116 | ..... | |
| 15,000 | .0150 | ..... | |
| 1,000 | ..... | .0010 | |

In reversing the load from 1,000 pounds per square inch tension to 1,000 pounds per square inch compression, the gauge showed a movement of ".0020.

NOTE.—Deducting the permanent set ".001 from the compression at 15,000 pounds per square inch, and we find a modulus of elacticity the same as for tension.

TENSION LOADS.

| Loads applied. | Pounds per square inch. | Elongation. | Permanent set. | Remarks. |
|---|---|---|---|---|
| *Pounds.* | | *Inch.* | *Inch* | |
| 3,142 | 1,000 | 0. | ..... | |
| 15,710 | 5,000 | .0040 | ..... | |
| 25,136 | 8,000 | .0075 | ..... | |
| 31,420 | 10,000 | .0095 | ..... | |
| ..... | 1,000 | ..... | .0005 | |
| 37,704 | 12,000 | .0115 | ..... | |
| 47,130 | 15,000 | .0148 | ..... | |
| ..... | 1,000 | ..... | .0004 | |

COMPRESSION LOADS.

| Pounds per square inch. | Compression. | Permanent set. | Remarks. |
|---|---|---|---|
| | *Inch.* | *Inch.* | |
| 1,000 | 0. | ..... | |
| 5,000 | .0044 | ..... | |
| 8,000 | .0076 | ..... | |
| 10,000 | .0096 | ..... | |
| 1,000 | ..... | .0004 | |
| 12,000 | .0116 | ..... | |
| 15,000 | .0149 | ..... | |
| 1,000 | ..... | .0004 | |

The gaugings in last test were taken with the "friction dial" measuring instrument. To verify these measurements the screw micrometer is now placed on the specimen.

TENSION LOADS.

| Pounds per square inch. | Elongation. | Permanent set. | Remarks. |
|---|---|---|---|
| | *Inch.* | *Inch.* | |
| 1,000 | 0. | ..... | Test resumed after Bar had rested under zero load sixty-two hours. |
| 5,000 | .0045 | ..... | |
| 8,000 | .0078 | ..... | |
| 10,000 | .0099 | ..... | |
| 1,000 | ..... | .0009 | |
| 12,000 | .0122 | ..... | |
| 15,000 | .0154 | ..... | |
| 1,000 | ..... | .0010 | |

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COMPRESSION LOADS.

| Pounds per square inch. | Compression. | Permanent set. | Remarks. |
|---|---|---|---|
| | *Inch.* | *Inch.* | |
| 1,000 | 0. | ..... | |
| 5,000 | .0040 | ..... | |
| 8,000 | .0070 | ..... | |
| 10,000 | .0092 | ..... | |
| 1,000 | ..... | .0001 | |
| 12,000 | .0121 | ..... | |
| 15,000 | .0142 | ..... | |
| 1,000 | ..... | .0001 | |

## No. 334.

### PHŒNIX IRON.

Off same bar as No. 333.
2¼″ rough bar turned down to 2″.003.
Sectional area, 3.142 square inches.
Gauged length, 30″.

COMPRESSION LOADS.

| Pounds per square inch. | Compression. | Permanent set. | Remarks. |
|---|---|---|---|
| | *Inch.* | *Inch.* | |
| 1,000 | 0. | ..... | |
| 5,000 | .0040 | ..... | |
| 8,000 | .0068 | ..... | |
| 10,000 | .0088 | ..... | |
| 1,000 | ..... | —.0002 | |
| 12,000 | .0108 | ..... | |
| 15,000 | .0139 | ..... | E = 20,800,000. |
| 1,000 | ..... | —.0002 | |

TENSION LOADS.

| Pounds per square inch. | Elongation. | Permanent set. | Remarks. |
|---|---|---|---|
| | *Inch.* | *Inch.* | |
| 1,000 | 0. | ..... | |
| 5,000 | .0044 | ..... | |
| 8,000 | .0075 | ..... | |
| 10,000 | .0095 | ..... | |
| 1,000 | ..... | .0007 | |
| 12,000 | .0117 | ..... | |
| 15,000 | .0147 | ..... | E = 29,580,000. |
| 1,000 | ..... | .0005 | |

COMPRESSION LOADS.

| Pounds per square inch. | Compression. | Permanent set. | Remarks. |
|---|---|---|---|
| | *Inch.* | *Inch.* | |
| 1,000 | 0. | ..... | |
| 5,000 | .0042 | ..... | |
| 8,000 | .0072 | ..... | |
| 10,000 | .0095 | ..... | |
| 1,000 | ..... | .0005 | |
| 12,000 | .0115 | ..... | |
| 15,000 | .0148 | ..... | |
| 1,000 | ..... | .0005 | |

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TENSION LOADS.

| Pounds per square inch. | Elongation. | Permanent set. | Remarks. |
|---|---|---|---|
| | *Inch.* | *Inch.* | |
| 1,000 | 0. | | |
| 5,000 | .0040 | | |
| 8,000 | .0074 | | |
| 10,000 | .0095 | | |
| 1,000 | | .0005 | |
| 12,000 | .0115 | | |
| 15,000 | .0147 | | |
| 1,000 | | .0005 | |

## No. 335.

## PENCOYD IRON.

2¼″ rough bar turned down to 1″.995 diameter.
Sectional area, 3.126 square inches.
Gauged length, 30″.

TENSION LOADS.

| Loads applied. | Pounds per square inch. | Elongation. | Permanent set. | Remarks. |
|---|---|---|---|---|
| *Pounds.* | | *Inch.* | *Inch.* | |
| 3,126 | 1,000 | 0. | | |
| 15,630 | 5,000 | .0044 | | |
| 25,008 | 8,000 | .0074 | | |
| 31,260 | 10,000 | .0094 | | |
| | 1,000 | | .0004 | |
| 37,512 | 12,000 | .0115 | | |
| 46,890 | 15,000 | .0144 | —.0001 | |
| | 1,000 | | | |
| | 15,000 | .0144 | | |
| | 1,000 | | —.0002 | |
| | 15,000 | .0144 | | |
| | 1,000 | | 0. | |
| | 10,000 | .0095 | | |
| | 1,000 | | 0. | |
| 56,268 | 18,000 | .0168 | | |
| 62,520 | 20,000 | .0185 | | |
| | 1,000 | | —.0012 | |
| | 5,000 | .0037 | | |
| | 8,000 | .0070 | | |
| | 10,000 | .0092 | | |
| | 1,000 | | 0. | |
| | 1,000 | | 0.+ | After resting 5 minutes. |
| | 1,000 | | —.0001 | After resting 15 minutes. |
| | 10,000 | .0093 | | |
| | 15,000 | .0148 | | |
| | 20,000 | .0203 | | |
| | 1,000 | | .0003 | |
| 68,770 | 22,000 | .0210 | | |
| 71,898 | 23,000 | .0220 | | |
| 75,024 | 24,000 | .0231 | | |
| 76,587 | 24,500 | .0235 | | |
| 78,150 | 25,000 | | | Sustained momentarily. |
| | 1,000 | | —.0014 | Springing the micrometer will vary the reading permanently about ″.0003. In use this springing would not occur. The springing was done experimentally. Load sustained momentarily. |
| | 25,000 | .0240 | | |
| 79,713 | 25,500 | .0244 | | |
| 81,276 | 26,000 | .0249 | | |
| 82,839 | 26,500 | .0255 | | |
| 84,402 | 27,000 | .0262 | | |
| 85,965 | 27,500 | .0271 | | |
| 87,528 | 28,000 | | | |
| | 1,000 | | —.0006 | |

REMARKS.—It has been observed in the test of some flat rolled bars that permanent sets caused by loads of 10,000 pounds per square inch, or about that, were eliminated by higher strains, and, also, there has in a few cases appeared a permanent shortening

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after the bar had been elongated. The apparent shortening was attributed to straightening of the bars in previous tests where this behavior occurred.

In the present instance, with a carefully turned bar, such an explanation as the above is obviously inadmissible. It would now appear that the above bar had initial strains which were released or some molecular arrangement broken up at 15,000 pounds per square inch, which enabled the bar to recover its original length upon the removal of that load, and even contract slightly, giving a minus sign to the permanent set.

This behavior is more marked after the bar was strained 20,000 pounds per square inch.

The measuring instrument, a micrometer screw, was carefully inspected to see that an instrumental error was not the cause of the minus permanent sets, but the instrument was found in good condition.

In corroboration of the micrometer measuring instrument, the scale beam of the testing-machine gave indication that a shortening of the specimen took place immediately after the strains were reduced to the initial load of 1,000 pounds per square inch.

After six months' rest, bar tested to the ultimate breaking strength = 163,800 pounds = 52,400 pounds per square inch.

Diameter of fracture, 1″.54 = 1.86 square inches; contraction of area, 40.5 per cent.; appearance fibrous, with slight granulation.

## No. 336.

### PENCOYD IRON.

Off same bar as No. 335.
Diameter, 2″.000.
Sectional area, 3.142 square inches.
Gauged length, 30″.
Friction dial used for measurement.

TENSION LOADS.

| Loads applied. | Pounds per square inch. | Elongation. | Permanent set. | Remarks. |
|---|---|---|---|---|
| *Pounds.* | | *Inch.* | *Inch.* | |
| 3,142 | 1,000 | 0. | ..... | |
| 15,710 | 5,000 | .0042 | ..... | |
| 25,136 | 8,000 | .0075 | ..... | |
| 31,420 | 10,000 | .0098 | ..... | |
| ..... | 1,000 | ..... | .0001 | |
| 37,704 | 12,000 | .0120 | ..... | |
| 47,130 | 15,000 | .0150 | ..... | |
| ..... | 1,000 | ..... | 0. | |
| 56,556 | 18,000 | .0179 | ..... | |
| 62,840 | 20,000 | .0194 | ..... | |
| ..... | 1,000 | ..... | −.0008 | |
| 72,266 | 23,000 | .6223 | ..... | |
| ..... | 1,000 | ..... | −.0010 | |
| 78,550 | 25,000 | .0243 | ..... | |
| ..... | 1,000 | ..... | −.0012 | |

In the test of No. 336 another measuring instrument was used—the friction dial instrument.

This bar, which was cut off the end of No. 335, showed a similar behavior to it, and as the dial-measuring instrument and the scale beam again in this case pointed to the same result, it is believed that a permanent shortening of the specimens did actually take place after loads between 15,000 pounds per square inch and 25,000 pounds per square inch had been applied and released.

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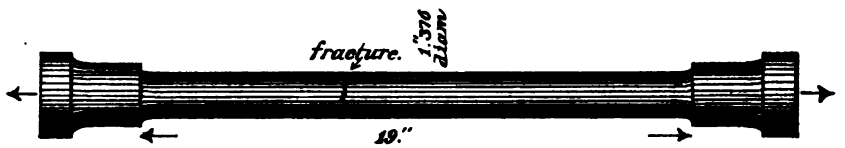
No. 354.

CAST IRON.

*Tensile test of cast (gun) iron from South Boston Iron Company.*

Mark on specimen: "No. 5, Block B."

FORM OF TEST PIECE.




Sectional area, 1.5 square inches.
Gauged length, 15".

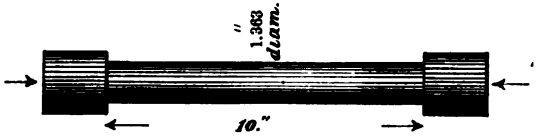
| Loads applied. | Pounds per square inch. | Elongation. | Permanent set. | Remarks. |
|---|---|---|---|---|
| *Pounds.* | | *Inch.* | *Inch.* | |
| 1,500 | 1,000 | .0003 | 0. | |
| 3,000 | 2,000 | .0005 | 0. | |
| 4,500 | 3,000 | .0014 | 0. | |
| 6,000 | 4,000 | .0020 | 0. | |
| 7,500 | 5,000 | .0030 | 0. | |
| 9,000 | 6,000 | .0040 | 0. | |
| 10,500 | 7,000 | .0050 | .0003 | |
| 12,000 | 8,000 | .0060 | .0005 | |
| 13,500 | 9,000 | .0070 | .0005 | |
| 15,000 | 10,000 | .0083 | .0005 | |
| 16,500 | 11,000 | .0094 | .0006 | |
| 18,000 | 12,000 | .0105 | .0007 | |
| 19,500 | 13,000 | .0120 | .0013 | |
| 21,000 | 14,000 | .0133 | .0015 | |
| 22,500 | 15,000 | .0147 | .0019 | |
| 24,000 | 16,000 | .0164 | .0025 | |
| 25,500 | 17,000 | .0180 | .0030 | |
| 27,000 | 18,000 | .0204 | .0036 | |
| 28,500 | 19,000 | .0224 | .0045 | |
| 30,000 | 20,000 | .0250 | .0059 | |
| 31,500 | 21,000 | .0285 | .0080 | |
| 33,000 | 22,000 | .0325 | .0105 | |
| 34,500 | 23,000 | .0380 | .0145 | |
| 36,000 | 24,000 | .0446 | .0195 | |
| 37,500 | 25,000 | ..... | ..... | Ultimate strength. |

Broke $1\frac{3}{4}$" from middle of bar.

No. 355.

*Compression test of cast (gun) iron from South Boston Iron Company.*

Mark on specimen: "No. 5, Block. A."




Sectional area, 1.46 square inches.
Gauged length, 10".

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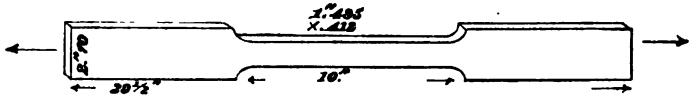
| Loads applied. | Pounds per square inch. | Compression. | Permanent set. | Remarks. |
|---|---|---|---|---|
| *Pounds.* | | *Inch.* | *Inch.* | |
| 1,460 | 1,000 | .0005 | 0. | |
| 2,920 | 2,000 | .0016 | 0. | |
| 4,380 | 3,000 | .0018 | 0. | |
| 5,840 | 4,000 | .0025 | .0002 | |
| 7,300 | 5,000 | .0030 | .0005 | |
| 8,760 | 6,000 | .0040 | .0005 | |
| 10,220 | 7,000 | .0045 | .0005 | |
| 11,680 | 8,000 | .0050 | .0005 | |
| 13,140 | 9,000 | .0060 | .0006 | |
| 14,600 | 10,000 | .0074 | .0007 | |
| 16,060 | 11,000 | .0075 | .0008 | |
| 17,520 | 12,000 | .0080 | .0010 | |
| 18,980 | 13,000 | .0082 | .0010 | |
| 20,440 | 14,000 | .0090 | .0010 | |
| 21,900 | 15,000 | .0100 | .0010 | |
| 23,360 | 16,000 | .0105 | .0012 | |
| 24,820 | 17,000 | .0105 | .0012 | |
| 26,280 | 18,000 | .0116 | .0010 | |
| 27,740 | 19,000 | .0125 | .0010 | |
| 29,200 | 20,000 | .0130 | .0015 | |
| 30,660 | 21,000 | .0140 | .0014 | |
| 32,120 | 22,000 | .0150 | .0020 | |
| 33,580 | 23,000 | .0158 | .0019 | |
| 35,040 | 24,000 | .0165 | .0030 | |
| 36,500 | 25,000 | .0174 | .0030 | |
| 37,960 | 26,000 | .0185 | .0030 | |
| 39,420 | 27,000 | .0200 | .0032 | |
| 40,880 | 28,000 | .0205 | .0048 | |
| 42,340 | 29,000 | .0225 | .0048 | |
| 43,800 | 30,000 | .0234 | .0054 | |
| 45,260 | 31,000 | .0251 | .0068 | |
| 46,720 | 32,000 | .0270 | .0076 | |
| 48,180 | 33,000 | .0290 | .0092 | |
| 49,640 | 34,000 | .0310 | .0110 | |
| 51,100 | 35,000 | .0332 | .0130 | |
| 52,560 | 36,000 | .0359 | .0150 | |
| 54,020 | 37,000 | .0400 | .0180 | |
| 55,480 | 38,000 | .0427 | .0205 | |
| 56,940 | 39,000 | .0475 | .0242 | |
| 58,400 | 40,000 | .0516 | .0280 | |
| 108,800 | 74,520 | ..... | ..... | Ultimate strength. |

SHAPE AFTER FRACTURE.

No. 382.

*Tensile test of gun-metal (bronze) used in cavalry forge cart—details.*




**Sectional area, .616 square inch.**
**Gauged length, 10″.**

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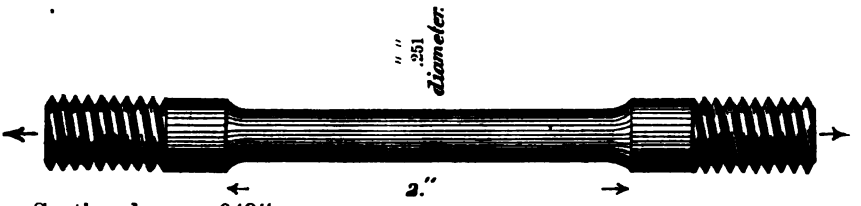
| Loads applied. | Pounds per square inch. | Elongation. | Permanent set. | Remarks. |
|---|---|---|---|---|
| *Pounds.* | | *Inch.* | *Inch.* | |
| 5,000 | | 0. | | Elongations measured from load of 5,000 pounds. |
| 6,000 | | .0013 | | |
| 7,000 | | .0028 | | |
| 8,000 | | .0042 | | |
| 9,000 | | .0061 | | |
| 9,800 | 15,910 | | | Elastic limit. |
| 10,000 | | .0082 | | |
| 5,000 | | | .0019 | |
| 10,500 | | .0100 | | |
| 11,000 | | .0116 | | |
| 11,500 | | .0140 | | |
| 12,000 | | .0176 | | |
| 12,500 | | .0200 | | |
| 5,000 | | | .0100 | |
| 13,000 | | .0239 | | |
| 14,000 | | .0340 | | |
| 15,000 | | .0496 | | |
| 18,900 | 30,680 | | | Ultimate strength. |
| 0 | 0 | .15 | | = 1.5 per cent. |

Broke, about $\frac{1}{4}''$ from curve of neck.
Fracture, dull color.
Fractured, with slight contraction.

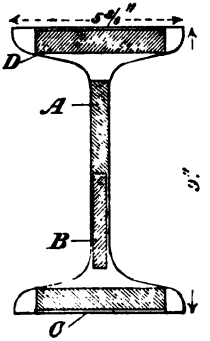
No. 383.

*Tensile test of gun-metal cut from nave, cavalry forge cart.*




Sectional area, .049".
Ultimate strength, 1,605 pounds= 32,760 pounds per square inch.
Broke about $\frac{1}{16}''$ from middle of specimen.
Elongation about ".29 in 2" =14½ per cent.
Fracture bright, varying in color.

*Test of a 9" wrought-iron I beam by strains of tension and compression.*




Tensile specimens *A*, *B*, *C*, and *D* cut out of beam, as shown by the sketch.

Specimen *A* has planed edges and rough sides. Specimens *B*, *C*, and D are planed on all faces. Specimen *E* compression test of the full section of beam.

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No. 337.

*Tensile test of Specimen A.*

Size of bar, $3'' \times .65 = 1.95$ square inches.
Gauged length, 30″.

| Loads applied. | Pounds per square inch. | Elongation. | Permanent set. | Remarks. |
|---|---|---|---|---|
| *Pounds.* | | *Inch.* | *Inch.* | |
| 1,950 | 1,000 | | | |
| 9,750 | 5,000 | .0044 | | |
| 15,600 | 8,000 | .0077 | | |
| 19,500 | 10,000 | .0099 | | |
| | 1,000 | | 0. | |
| 23,400 | 12,000 | .0120 | | |
| 29,250 | 15,000 | .0153 | | |
| | 1,000 | | 0. | |
| 35,100 | 18,000 | .0189 | | |
| 39,000 | 20,000 | .0211 | | |
| | 1,000 | | .0009 | |
| 40,950 | 21,000 | .0227 | | |
| 42,900 | 22,000 | .0237 | | |
| 44,850 | 23,000 | .0249 | | |
| 46,800 | 24,000 | .0260 | | |
| 48,750 | 25,000 | .0277 | | E = 28,347,000. |
| | 1,000 | | .0019 | |
| 50,700 | 26,000 | .0290 | | |
| 52,650 | 27,000 | .0308 | | |
| 54,600 | 28,000 | .0320 | | |
| 56,550 | 29,000 | .0339 | | |
| 58,500 | 30,000 | .0361 | | |
| | 1,000 | | .0049 | |
| 60,450 | 31,000 | .0389 | | |
| 62,400 | 32,000 | .0417 | | |
| | 32,000 | .0427 | | After 3 minutes rest. |
| | 32,000 | .0429 | | After 5 minutes rest. |
| 64,350 | 33,000 | .0449 | | |
| 66,300 | 34,000 | .0487 | | |
| 68,250 | 35,000 | .0559 | | |
| 70,200 | 36,000 | .065 | | Yielding still continuing. |
| 103,300 | 52,970 | | | Ultimate strength. |
| 0 | 0 | 2 24 | | =7.5 per cent. |

Fractured 1″ outside of gauged length.
Appearance of fractures: Granular, 92 per cent.; fibrous, 8 per cent.
Area at fracture, $2''.92 \times .60 = 1.752$ square inches.
Contraction of area, 10 per cent.

No. 341.

*Tensile test of Specimen B.*

Size of bar, $3'' \times .503 = 1.509$ square inches.
Gauged length, 30″.

| Loads applied. | Pounds per square inch. | Elongation. | Permanent set. | Remarks. |
|---|---|---|---|---|
| *Pounds.* | | *Inch.* | *Inch.* | |
| 1,509 | 1,000 | 0. | | |
| 9,545 | 5,000 | .0060 | | |
| 12,072 | 8,000 | .0080 | | |
| 15,090 | 10,000 | .0101 | | |
| | 1,000 | | 0. | |
| 18,108 | 12,000 | .0122 | | |
| 24,635 | 15,000 | .0170 | | |

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| Loads applied. | Pounds per square inch. | Elongation. | Permanent set. | Remarks. |
|---|---|---|---|---|
| *Pounds.* | | *Inch.* | *Inch.* | |
| ..... | 1,000 | ..... | .0001 | |
| 27,162 | 18,000 | .0190 | ..... | |
| 30,180 | 20,000 | .0215 | ..... | |
| ..... | 1,000 | ..... | .0008 | |
| 33,198 | 22,000 | .0242 | ..... | |
| 36,216 | 24,000 | .0270 | ..... | |
| 37,725 | 25,000 | .0285 | ..... | E=27,376,000. |
| ..... | 1,000 | ..... | .0022 | |
| 39,234 | 26,000 | .0302 | ..... | |
| 40,743 | 27,000 | .0321 | ..... | |
| 42,252 | 28,000 | .0340 | ..... | |
| 43,761 | 29,000 | .0368 | ..... | |
| 45,270 | 30,000 | .0398 | ..... | |
| ..... | 1,000 | ..... | .0080 | |
| 46,779 | 31,000 | .0440 | ..... | |
| 48,288 | 32,000 | .0482 | ..... | |
| 49,797 | 33,000 | .0542 | ..... | |
| 51,306 | 34,000 | .065 | ..... | Yielding continues; stretch not all taken out which this load would cause. |
| 65,400 | 43,340 | ..... | ..... | Ultimate strength. |
| 0 | 0 | .78 | ..... | =2.6 per cent. |

Area at fracture, 2″.96 × ″.49 = 1.45 square inches; contraction of area, 3.9 per cent.
Fracture: Granular, 95 per cent.; fibrous, 05 per cent.
Appearance of bar not clean; seamy.

No. 342.

*Tensile test of Specimen C.*

Size of bar, 4″.003 × ″.752 = 3.01 square inches.
Gauged length, 30″.

| Loads applied. | Pounds per square inch. | Elongation. | Permanent set. | Remarks. |
|---|---|---|---|---|
| *Pounds.* | | *Inch.* | *Inch.* | |
| 3,010 | 1,000 | 0. | ..... | |
| 15,050 | 5,000 | .0046 | ..... | |
| 24,080 | 8,000 | .0078 | ..... | |
| 30,100 | 10,000 | .0102 | ..... | |
| ..... | 1,000 | ..... | .0008 | |
| 36,120 | 12,000 | .0128 | ..... | |
| 45,150 | 15,000 | .0159 | ..... | |
| ..... | 1,000 | ..... | .0009 | |
| 54,180 | 18,000 | .0199 | ..... | |
| 60,200 | 20,000 | .0238 | ..... | E=28,500,000. |
| ..... | 1,000 | ..... | .0038 | |
| 66,220 | 22,000 | .0296 | ..... | |
| 72,240 | 24,000 | .0399 | ..... | |
| 75,250 | 25,000 | .0518 | ..... | |
| ..... | 1,000 | ..... | .0256 | |
| 146,400 | 48,640 | ..... | ..... | Ultimate strength. |
| 0 | 0 | 5.25 | ..... | =17.5 per cent. |

Area at fracture, 3″.67 × ″.66 = 2.42 square inches.
Contraction of area, 19.6 per cent.
Fibrous fracture, good appearance.
Began to break on one edge, extending across.

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No. 343.

*Tensile test of Specimen D.*

Size of bar, $4'' \times .756 = 3.024$ square inches.
Gauged length, 30″.

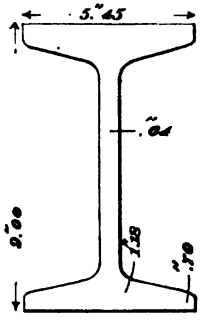
| Loads applied. | Pounds per square inch. | Elongation. | Permanent set. | Remarks. |
|---|---|---|---|---|
| *Pounds.* | | *Inch.* | *Inch.* | |
| 3,024 | 1,000 | .0 | | |
| 15,120 | 5,000 | .0044 | | |
| 24,192 | 8,000 | .0077 | | |
| 30,240 | 10,000 | .0099 | | |
| | 1,000 | | .0001 | |
| | 1,000 | | .0001 | |
| 36,288 | 12,000 | .0117 | | |
| 45,360 | 15,000 | .0151 | | |
| | 1,000 | | .0001 | |
| 54,432 | 18,000 | .0186 | | |
| 60,480 | 20,000 | .0211 | | E = 28,078,000. |
| | 1,000 | | .0008 | |
| 66,528 | 22,000 | .0254 | | |
| 69,552 | 23,000 | .0276 | | |
| 72,576 | 24,000 | .0306 | | |
| 75,600 | 25,000 | .0357 | | |
| | 1,000 | | .0106 | |
| 78,624 | 26,000 | .0431 | | Yielding continues. |
| 81,648 | 27,000 | .0590 | | Do. |
| 147,100 | 48,640 | | | Ultimate strength. |
| 0 | 0 | 3.95 | | = 13.2 per cent. |

Area at fracture, $3''.74 \times .68 = 2.543$ square inches.
Contraction of area, 15.9 per cent.
Fracture: Fibrous, 90 per cent; granular, 10 per cent.
Fracture began at edge of bar.
This bar was not straight—slightly concave on the side that measurements of elongation were taken.

No. 344.

*Test by compression of* I *beam.*

SPECIMEN E.




Total length, 57″.06.
Weight, 228 pounds.
Sectional area, 14.4 square inches.
Gauged length, 50″.

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| Loads applied. | Pounds per square inch. | Compression. | Permanent set. | Remarks. |
|---|---|---|---|---|
| *Pounds.* | | *Inch.* | *Inch.* | |
| 14,400 | 1,000 | 0. | ..... | |
| 72,000 | 5,000 | .0058 | ..... | |
| 115,200 | 8,000 | .0108 | ..... | |
| 144,000 | 10,000 | .0142 | ..... | |
| ..... | 1,000 | ..... | .0014 | |
| ..... | 10,000 | .0145 | ..... | |
| ..... | 1,000 | ..... | .0014 | |
| 172,800 | 12,000 | .0175 | ..... | |
| 216,000 | 15,000 | .0230 | ..... | |
| ..... | 1,000 | ..... | .0010 | |
| ..... | 15,000 | .0230 | ..... | |
| ..... | 1,000 | ..... | .0014 | |
| 259,200 | 18,000 | ..... | ..... | |
| 288,000 | 20,000 | .0330 | ..... | E = 31,250,000. |
| ..... | 1,000 | ..... | .0026 | |
| ..... | 18,000 | .0298 | ..... | |
| ..... | 20,000 | .0330 | ..... | |
| ..... | 1,000 | ..... | .0026 | |
| 316,800 | 22,000 | .0370 | ..... | |
| 345,600 | 24,000 | .0415 | ..... | |
| 360,000 | 25,000 | .0440 | ..... | |
| ..... | 1,000 | ..... | .0059 | |
| 374,400 | 26,000 | .0475 | ..... | |
| 388,800 | 27,000 | .0500 | ..... | |
| 403,200 | 28,000 | .0534 | ..... | |
| 417,600 | 29,000 | .0585 | ..... | |
| 432,000 | 30,000 | .0630 | ..... | |
| ..... | 30,000 | .0660 | ..... | After 5 minutes' rest. |
| ..... | 1,000 | ..... | .0195 | |
| 460,800 | 32,000 | .0835 | ..... | |
| ..... | 32,000 | .0922 | ..... | After 4 minutes' rest. |
| 545,100 | 37,854 | ..... | ..... | Ultimate strength. |

Beam failed by horizontal deflection, or in the direction perpendicular to the web, beam taking triple flexure.

When deflection reached about 1″, the test was discontinued. The load the beam was sustaining at the time was 538,000 pounds.

## 10″ Wrought Iron I Beam.

(Rolled by Union Iron Company, Buffalo, N. Y.)

*Tests by tension and compression.*

### No. 345.

Specimen planed out of flange of beam.
Dimensions, 48″ × 3″ × ″.51.
Sectional area, 1.53 square inches.
Gauged length, 30″.
Metal has poor appearance; porous.

| Loads applied. | Pounds per square inch. | Elongation. | Permanent set. | Remarks. |
|---|---|---|---|---|
| *Pounds.* | | *Inch.* | *Inch.* | |
| 1,530 | 1,000 | 0. | ..... | |
| 7,650 | 5,000 | .0043 | ..... | |
| 12,240 | 8,000 | .0076 | ..... | |
| 15,300 | 10,000 | .0100 | ..... | |
| ..... | 1,000 | ..... | .0001 | |
| 18,360 | 12,000 | .0121 | ..... | |
| 22,950 | 15,000 | .0156 | ..... | |
| 27,540 | 18,000 | .0192 | ..... | |
| 30,600 | 20,000 | .0221 | ..... | |
| ..... | 1,000 | ..... | .0011 | |
| 43,700 | 28,560 | ..... | ..... | Elastic limit. |
| 55,400 | 36,210 | ..... | ..... | Ultimate strength. |
| 0 | 0 | .65 | ..... | = 2.2 per cent. |

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Area at fracture, 2″.90×″.47=1.36 square inches.
Contraction of area, 11.1 per cent.
Appearance of fracture, dull, spongy.

No. 346.

Specimen planed out of web of beam.
Dimensions, 48″×3″×″.395.
Sectional area, 1.185 square inches.
Gauged length, 30″.

| Loads applied. | Pounds per square inch. | Elongation. | Permanent set. | Remarks. |
|---|---|---|---|---|
| *Pounds.* | | *Inch.* | *Inch.* | |
| 1,185 | 1,000 | 0. | | |
| 5,925 | 5,000 | .0042 | | |
| 9,480 | 8,000 | .0072 | | |
| 11,850 | 10,000 | .0097 | | |
| | 1,000 | | .0003 | |
| 14,220 | 12,000 | .0122 | | |
| 17,775 | 15,000 | .0153 | | |
| 21,330 | 18,000 | .0191 | | |
| 23,700 | 20,000 | .0213 | | |
| | 1,000 | | .0014 | |
| 29,900 | 25,230 | | | Elastic limit. |
| 52,900 | 44,640 | | | Ultimate strength. |
| 0 | 0 | 2.17 | | =7.2 per cent. |

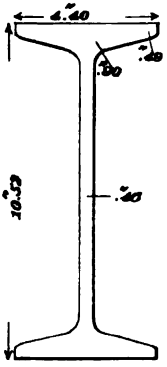
Area at fracture, 2″.90×″.34 = .99 square inch.
Contraction of area, 16.5 per cent.
Appearance at fracture dull, spongy; small granular spot.

No. 347.

*Compression test of wrought iron.*

I-BEAM.

Specimens No. 345 and No. 346 were cut off one end of this beam.



Tested with flat ends, counterweighted at middle.
Total length, 155″.45.
Total weight, 443 pounds.
Gauged length, 150″.
Sectional area, 10.26 square inches.

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| Loads applied. | Pounds per square inch. | Compression. | Permanent set. | Deflections. | | Remarks. |
|---|---|---|---|---|---|---|
| | | | | Horizontal. | Vertical. | |
| *Pounds.* | | *Inch.* | *Inch.* | *Inch.* | *Inch.* | |
| 10, 260 | 1, 000 | 0. | ..... | 0. | 0. | |
| 51, 300 | 5, 000 | .0185 | ..... | 0. | 0. | |
| 102, 600 | 10, 000 | .0440 | ..... | 0. | .02 | |
| ..... | 1, 000 | 0. | 0. | 0. | 0. | |
| 123, 120 | 12, 000 | .0542 | ..... | .05 | .02 | |
| 153, 900 | 15, 000 | .0694 | ..... | .10 | .02 | |
| ..... | 1, 000 | ..... | 0. | 0. | 0. | |
| 184, 680 | 18, 000 | .0846 | ..... | .15 | .05 | |
| 205, 200 | 20, 000 | .0962 | ..... | .30 | .10 | |
| ..... | 1, 000 | ..... | — .0002 | .09 | .06 | |
| 207, 000 | 20, 170 | ..... | ..... | ..... | ..... | Ultimate strength. |

**Failed by horizontal deflection.**
**Took sharp bend at middle.**

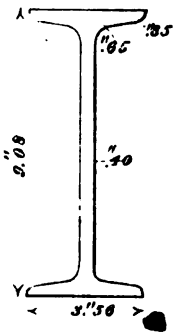
### *Compression tests of wrought-iron I beams.*

**Flat ends. Placed in testing machine with webs vertical.**

### No. 348.

### 9″ I BEAM.

### (Rolled by Union Iron Company, Buffalo, N. Y.)




**Total length, 191″.90.**
**Total weight, 365 pounds.**
**Sectional area, 6.85 square inches.**
**Gauged length, 150″.**

| Loads applied. | Pounds per square inch. | Compression. | Permanent set. | Deflections. | | Remarks. |
|---|---|---|---|---|---|---|
| | | | | Horizontal. | Vertical. | |
| *Pounds.* | | *Inch.* | *Inch.* | *Inch.* | *Inch.* | |
| 6, 850 | 1, 000 | 0. | ..... | 0. | 0. | |
| 34, 250 | 5, 000 | .0215 | ..... | — .07 | 0. | |
| 54, 800 | 8, 000 | .0380 | ..... | — .11 | .05 | |
| 68, 500 | 10, 000 | .0501 | ..... | — .20 | .06 | |
| ..... | 1, 000 | ..... | 0. | 0. | 0. | |
| 82, 200 | 12, 000 | .0665 | ..... | — .43 | .04 | |
| 85, 380 | 12, 460 | ..... | ..... | — .78 | 0. | Ultimate strength. |

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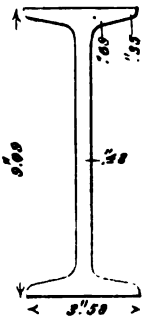
After passing the ultimate load, strains were continued, the horizontal deflection increasing rapidly, but not with a sudden spring.

When the horizontal deflection had reached 3″.7, the load sustained was 40,000 pounds.

No. 349.

Duplicate of beam No. 348.



Total length, 191″.90.
Total weight, 381 pounds.
Gauged length, 150″.
Sectional area, 7.15 square inches.

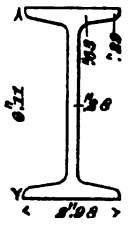
| Loads applied. | Pounds per square inch. | Compression. | Permanent set. | Deflections. | | Remarks. |
|---|---|---|---|---|---|---|
| | | | | Horizontal. | Vertical. | |
| *Pounds.* | | *Inch.* | *Inch.* | *Inch.* | *Inch.* | |
| 7,150 | 1,000 | 0. | ..... | 0. | 0. | |
| 35,750 | 5,000 | .0208 | ..... | − .07 | 0. | |
| 57,200 | 8,000 | .0375 | ..... | − .13 | 0. | |
| 71,500 | 10,000 | .0495 | ..... | − .25 | 0. | |
| ..... | 1,000 | ..... | 0. | 0. | 0. | |
| 85,200 | ..... | ..... | ..... | − .82 | 0. | Ultimate strength. |

Failed by horizontal deflection.

No. 350.

6″ I BEAM.

(Rolled by Union Iron Company.)



Length, 119″.85.
Weight, 139 pounds.

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Sectional area, 4.18 square inches.
Gauged length, 100″.

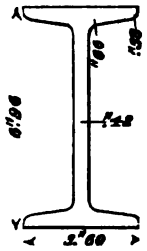
| Loads applied. | Pounds per square inch. | Compression. | Permanent set. | Deflections. | | Remarks. |
|---|---|---|---|---|---|---|
| | | | | Horizontal. | Vertical. | |
| *Pounds.* | | *Inch.* | *Inch.* | *Inch.* | *Inch.* | |
| 4, 180 | 1, 000 | 0. | | 0. | 0. | |
| 20, 900 | 5, 000 | .0130 | | 0. | 0. | |
| 33, 440 | 8, 000 | .0234 | | — .01 | 0. | |
| 41, 800 | 10, 000 | .0302 | | — .03 | 0. | |
| | 1, 000 | | 0. | 0. | 0. | |
| 50, 160 | 12, 000 | .0372 | | — .03 | 0. | |
| 101, 200 | 24, 210 | | | — .60 | | Ultimate strength. |

Failed by horizontal deflection.

No. 351.

7″ I BEAM.

(Rolled by Union Iron Company.)



Total length, 180″.33.
Total weight, 303 pounds.
Sectional area, 6.05 square inches.
Gauged length, 150″.

| Loads applied. | Pounds per square inch. | Compression. | Permanent set. | Deflections. | | Remarks. |
|---|---|---|---|---|---|---|
| | | | | Horizontal. | Vertical. | |
| *Pounds.* | | *Inch.* | *Inch.* | *Inch.* | *Inch.* | |
| 6, 050 | 1, 000 | 0. | | 0. | 0. | |
| 30, 250 | 5, 000 | .0270 | | — .08 | — .03 | |
| 48, 400 | 8, 000 | .0445 | | — .15 | — .04 | |
| 60, 500 | 10, 000 | .0570 | | — .23 | — .04 | |
| | 1, 000 | | .0006 | 0. | 0. | |
| 76, 200 | 12, 000 | .0761 | | — .43 | — .04 | |
| 84, 650 | 13, 990 | | | — .95 | — .02 | Ultimate strength. |

Failed by horizontal deflection.



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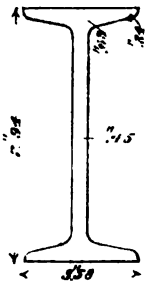
## No. 352.

### 8″ I BEAM.

(Rolled by Union Iron Company, Buffalo, N. Y.)



Total length, 192″.04.
Total weight, 355 pounds.
Sectional area, 6.65 square inches.
Gauged length, 150″.

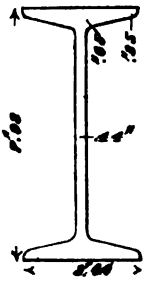
| Loads applied. | Pounds per square inch. | Compression. | Permanent set. | Deflections. Horizontal. | Deflections. Vertical. | Remarks. |
|---|---|---|---|---|---|---|
| *Pounds.* | | *Inch.* | *Inch.* | *Inch.* | *Inch.* | |
| 6,650 | 1,000 | 0. | | 0. | 0. | |
| 33,250 | 5,000 | .0190 | | + .07 | — .02 | |
| 53,200 | 8,000 | .0340 | | .11 | — .04 | |
| 6,650 | 10,000 | .0430 | | .16 | — .04 | |
| | 1,000 | | — .0010 | .04 | 0. | |
| Released strain and changed packing behind the ends. | | | | | | |
| | 1,000 | 0. | 0. | 0. | 0. | New gaugings began. |
| | 5,000 | .0210 | | 0. | 0. | |
| | 8,000 | .0372 | | — .05 | 0. | |
| | 10,000 | .0485 | | — .12 | 0. | |
| | 1,000 | | 0. | 0. | 0. | |
| 79,800 | 12,000 | .0630 | | — .35 | 0. | |
| 83,400 | 12,540 | | | —1.05 | 0. | Ultimate strength. |

Failed by horizontal deflection.

## No. 353.

### 8″ BEAM.

Duplicate of No. 352.



Total length, 192″.90.
Total weight, 353 pounds.
Sectional area, 6.59 square inches.
Gauged length, 150″.

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| Loads applied. | Pounds per square inch. | Compression. | Permanent set. | Deflections. | | Remarks. |
|---|---|---|---|---|---|---|
| | | | | Horizontal. | Vertical. | |
| *Pounds.* | | *Inch.* | *Inch.* | *Inch.* | *Inch.* | |
| 6,590 | 1,000 | 0. | .. ..... | 0. | 0. | |
| 32,950 | 5,000 | .0212 | ..... | 0. | — .06 | |
| 52,720 | 8,000 | .0388 | ..... | 0. | — .10 | |
| 65,900 | 10 000 | .0470 | ..... | 0. | — .10 | |
| ..... | 1,000 | ..... | — .0002 | 0. | — .04 | |
| 79,080 | 12,000 | .0570 | ..... | 0. | — .10 | |
| 92,300 | 14,010 | ..... | ..... | + .50 | — .10 | Ultimate strength. |

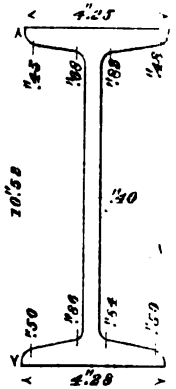
Failed by horizontal deflection.

After the ultimate load had been passed and the deflection had reached about 1″.25, the beam suddenly sprung laterally.

## No. 356.

### 10″ Wrought Iron I Beam.

(Rolled by Union Iron Company, Buffalo, N. Y.)




Total length, 215″.88.

Gauged length, 200″.

Weight, 561 pounds.

Sectional area, 9.3 square inches.

Counterweighted at middle. Ends did not come to good bearing; required about ″.05 brass packing; maximum amount.

| Loads applied. | Pounds per square inch. | Compression. | Permanent set. | Deflections. | | Remarks. |
|---|---|---|---|---|---|---|
| | | | | Horizontal. | Vertical. | |
| *Pounds.* | | *Inch.* | *Inch.* | *Inch.* | *Inch.* | |
| 9,300 | 1,000 | 0. | ..... | 0. | 0. | |
| 46,500 | 5,000 | .0271 | ..... | 0. | 0. | |
| 74,400 | 8,000 | .0490 | ..... | 0. | —.02 | |
| 93,000 | 10,000 | .0665 | ..... | 0. | —.04 | |
| 9,300 | 1,000 | ..... | .0050 | 0. | —.02 | |
| 111,600 | 12,000 | .0844 | ..... .. | — .03 | —.06 | |
| 120,900 | 13,000 | .0940 | ..... | — .05 | —.06 | |
| 130,200 | 14,000 | .1029 | ..... | — .08 | —.06 | |
| 139,500 | 15,000 | .1125 | ..... | — .17 | —.06 | |
| 9,300 | 1,000 | ..... | .0150 | 0. | —.04 | |
| 149,000 | 16,020 | ..... | ..... | — .76 | —.05 | |
| ..... | ..... | ..... | ..... | —1.20 | ..... | Ultimate strength. |
| 9,300 | 1,000 | ..... | ..... | — .20 | ..... | Maximum deflection. |

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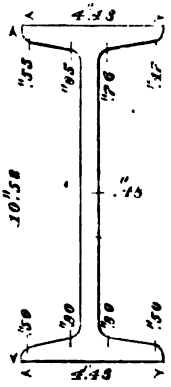
No. 357.

10″ I BEAM.

(Union Iron Company, Buffalo, N. Y.)



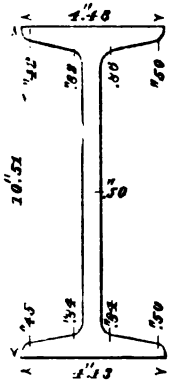
Total length, 264″.08.
Gauged length, 250″.
Sectional area, 10.19 square inches.
Weight, 747 pounds.
Counterweighted at middle.

| Loads applied. | Pounds per square inch. | Compression. | Permanent set. | Deflections. | | Remarks. |
|---|---|---|---|---|---|---|
| | | | | Horizontal. | Vertical. | |
| *Pounds.* | | *Inch.* | *Inch.* | *Inch.* | *Inch.* | |
| 10,190 | 1,000 | 0. | ..... | 0. | 0. | |
| 50,950 | 5,000 | .0335 | ..... | + .07 | + .02 | |
| 81,520 | 8,000 | .0604 | ..... | .12 | .03 | |
| 101,900 | 10,000 | .0785 | ..... | .25 | .03 | |
| ..... | 1,000 | ..... | .0020 | .03 | .02 | |
| 113,100 | 11,100 | ..... | ..... | 1.00 | .03 | Ultimate strength. |
| ..... | 1,000 | ..... | ..... | .08 | .02 | |

No. 358.

10″ I BEAM.

(Union Iron Company, Buffalo, N. Y.)



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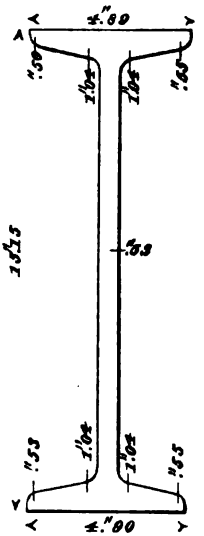
Total length, 264″.08.
Gauged length, 250″.
Sectional area, 10.46 square inches.
Weight, 767 pounds.
Counterweighted at middle.
Ends come to a good bearing.

| Loads applied. | Pounds per square inch. | Compression. | Permanent set. | Deflections. Horizontal. | Deflections. Vertical. | Remarks. |
|---|---|---|---|---|---|---|
| *Pounds.* | | *Inch.* | *Inch.* | *Inch.* | *Inch.* | |
| 10,460 | 1,000 | 0. | | 0. | 0. | |
| 52,300 | 5,000 | .0356 | | .20 | 0. | |
| 83,680 | 8,000 | .0629 | | .23 | 0. | |
| 104,600 | 10,000 | .0820 | | .70 | 0. | |
| | 1,000 | | 0. | 0. | 0. | |
| 107,800 | 10,306 | | | 1.14 | 0. | Ultimate strength. |
| | 1,000 | | | .05 | 0. | |
| | | Per deflection increased. | | | | |
| | 1,000 | | | .36 | 0. | |
| 82,000 | | | | 3.00 | | Sustains after above per deflection. |

## No. 359.

## 15″ WROUGHT-IRON I BEAM.

(Union Iron Company, Buffalo, N. Y.)



Total length, 264″.
Gauged length, 250″.
Sectional area, 14.8 square inches.
Weight, 1,085 pounds.
Counterweighted at middle.

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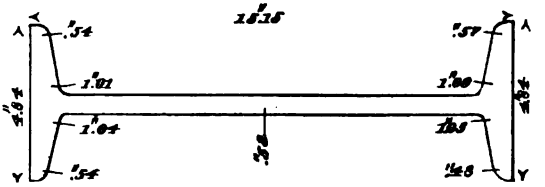
| Loads applied. | Pounds per square inch. | Compression. | Permanent set. | Deflections. | | Remarks. |
|---|---|---|---|---|---|---|
| | | | | Horizontal. | Vertical. | |
| *Pounds.* | | *Inch.* | *Inch.* | *Inch.* | *Inch.* | |
| 14,800 | 1,000 | 0. | ..... | 0. | 0. | |
| 74,000 | 5,000 | .0350 | ..... | 0. | 0. | |
| 118,400 | 8,000 | .0612 | ..... | 0. | 0. | |
| 148,000 | 10,000 | .0852 | ..... | — .07 | 0. | |
| ..... | 1,000 | ..... | .0060 | 0. | 0. | |
| 177,600 | 12,000 | ..... | ..... | — .20 | 0. | |
| 184,700 | 12,400 | ..... | ..... | — .70 | 0. | Ultimate strength. |

## No. 360.

### WROUGHT-IRON I BEAM.




Total length, 263".95.
Gauged length, 250".
Sectional area, 14.74 square inches.
Weight, 1,081 pounds.
Counterweighted at middle.
Ends come to good bearing without packing.

| Loads applied. | Pounds per square inch. | Compression. | Permanent set. | Deflections. | | Remarks. |
|---|---|---|---|---|---|---|
| | | | | Horizontal. | Vertical. | |
| *Pounds.* | | *Inch.* | *Inch.* | *Inch.* | *Inch.* | |
| 14,740 | 1,000 | 0. | ..... | 0. | 0. | |
| 73,700 | 5,000 | .0365 | ..... | 0. | 0. | |
| 117,920 | 8,000 | .0635 | ..... | 0. | 0. | Snapping sounds heard when load exceeded 8,000 pounds per square inch. |
| 147,400 | 10,000 | 1.0920 | ..... | + .02 | 0. | |
| ..... | 1,000 | ..... | .0130 | 0. | 0. | |
| 176,880 | 12,000 | ..... | ..... | .08 | 0. | |
| 187,000 | 12,686 | ..... | ..... | .70 | 0. | Ultimate strength. |

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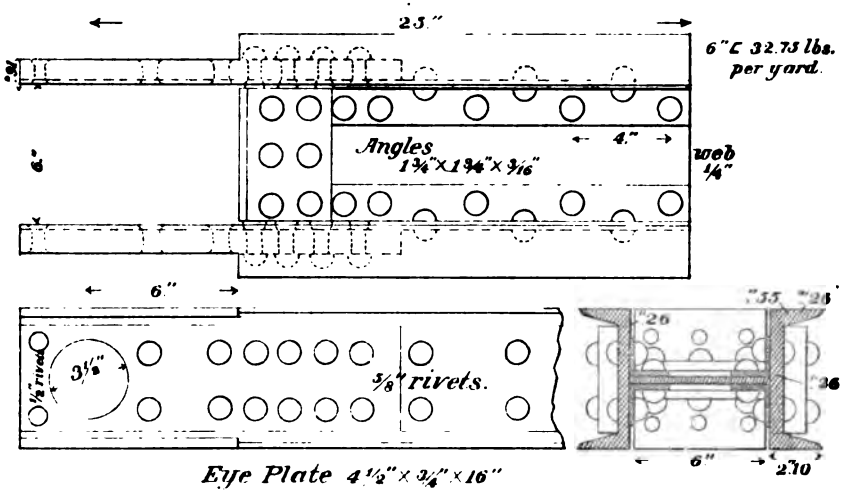
*Compression of pin ends of wrought iron posts.*

No. 391.

Tested with one pin end, one flat end.




*Eye Plate 4½"×¾"×16"*

Ultimate strength, 393,000 pounds.

Specimen tested with one pin end, one flat end. Pin in vertical position.

Post failed by deflecting perpendicular to axis of pin, buckling the flanges of the channel bars. The eye-plates were bent concave, and also the webs of channel bars, from the inside of the post.

Fracture of the channel-bar web occurred along one row of rivet holes, where riveted to eye-plate.

The pin ends were bent inward.

Strains were very gradually increased; yielding took place slowly.

No. 392.

*Compression of short pin and post.*

Duplicate of No. 391.

Ultimate strength, 415,000 pounds.

This post failed in a manner similar to No. 391, but without horizontal deflection. Each pin end bent inward. This failure occurred about the same time the channel-bar webs and eye-plates were bent concave from the inside of the post.

The concave bending of the webs was accompanied by outward buckling of the channel-bar flanges as far as the eye-plate reached.

Cripling was carried on till one channel-bar web cracked along the line of rivets which connects it to the eye-plate.

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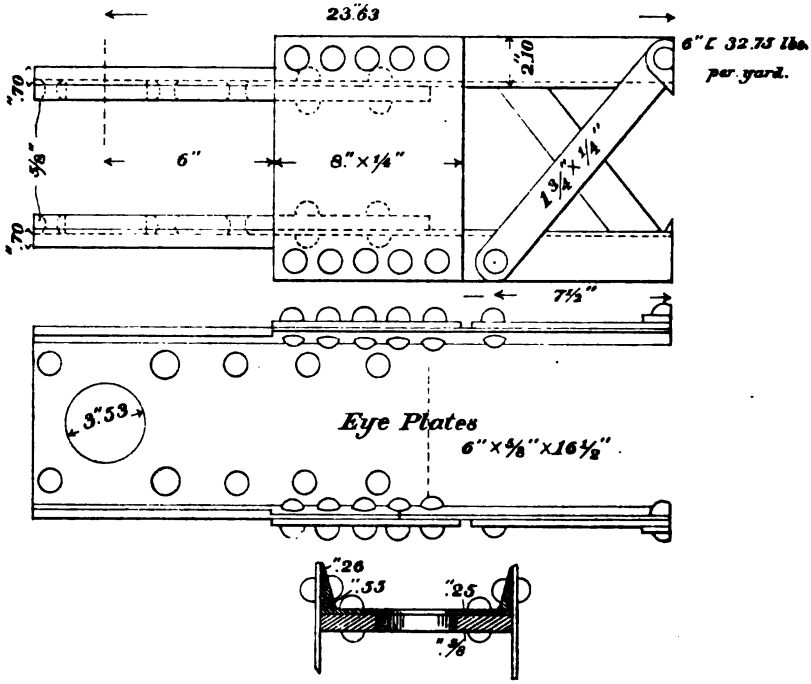
No. 393.

Tested with one pin end, one flat end.




⅝" rivets, except two end rivets, ½" each.

Same size channels as used in Nos. 391 and 392, punched holes.

Ultimate strength, 302,600 pounds.

Post failed by buckling the web and flanges of channel bars between flat end and side plates.

Secondary bending took place at the pin end, after considerable buckling had been given the channel bars.

No. 394.

Duplicate of No. 393.

Ultimate strength, 302,200 pounds.

Failed the same as No. 393.

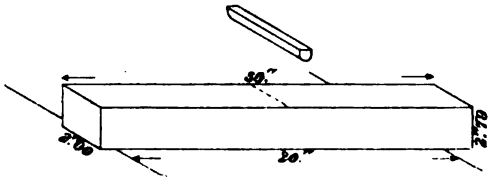
Slight bend of pin ends took place about the same time the channel bars buckled.

No. 361.

*Transverse test of wrought-iron bar.*

Hammered iron, very full of seams.

Specimen dressed all over.

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End bearings 20″ apart.
Loaded at middle.
Middle bearing semicircular, ½″ radius.

| Loads applied. | Δ | Δ set. | Remarks. |
|---|---|---|---|
| *Pounds.* | *Inch.* | *Inch.* | |
| 500 | .0036 | ..... | Loads released to zero when measuring Δ sets. |
| 1,000 | .0044 | .0001 | |
| 1,500 | .0051 | ..... | |
| 2,000 | .0061 | ..... | |
| 2,500 | .0070 | ..... | |
| 3,000 | .0078 | .0002 | |
| 4,000 | .0097 | ..... | |
| 5,000 | .0116 | .0002 | |
| 6,000 | 0131 | ..... | |
| 7,000 | .0148 | ..... | |
| 8,000 | .0154 | .0003 | |
| 9,000 | .0183 | ..... | |
| 10,000 | .0201 | ..... | |
| 11,000 | .0218 | ..... | |
| 12,000 | .0236 | .0009 | |
| 13,000 | .0257 | ..... | |
| 14,000 | .0279 | ..... | |
| 15,000 | .0301 | .0023 | |
| 16,000 | .0333 | ..... | |
| 17,000 | .0380 | .0066 | |
| 18,000 | .0551 | .0220 | |
| 19,000 | .0901 | ..... | |
| 20,000 | .1380 | .1002 | |
| 21,000 | .177 | ..... | |
| 22,000 | .226 | .184 | Micrometer removed. |
| 23,000 | .27 | ..... | |
| 24,000 | .35 | ..... | |
| 25,000 | .41 | ..... | |
| 27,000 | .55 | ..... | |
| 30,000 | .85 | ..... | |
| 35,000 | 1.74 | ..... | |
| 40,000 | 3.05 | ..... | |
| 43,800 | *5.5 | ..... | Ultimate strength. |

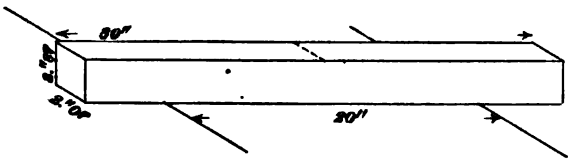
*About.

Test discontinued when the bar had been bent about 85°.
A 3″ section laid off on the tension side at the middle before the test began now measures 4″.27.
Elongation of outside fibers, 42 per cent.

## No. 1590.

*Transverse test of gun iron for South Boston Iron Company.*

Specimen dressed all over.




20″ between end supports.
Loaded at middle.
Middle bearing semicircular, ½″ radius.

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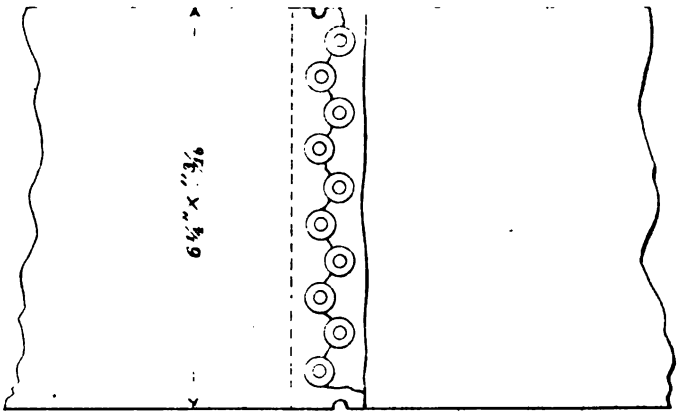
| Loads applied. | Δ | Δ set. | Remarks. |
|---|---|---|---|
| *Pounds.* | *Inch.* | *Inch.* | |
| 500 | .0017 | | Loads released to zero load when Δ sets were measured. |
| 1,000 | .0030 | .0002 | |
| 1,500 | .0040 | | |
| 2,000 | .0054 | .0002 | |
| 2,500 | .0070 | | |
| 3,000 | .0082 | .0003 | |
| 3,500 | .0088 | | |
| 4,000 | .0102 | .0002 | |
| 4,500 | .0112 | | |
| 5,000 | .0124 | .0001 | |
| 5,500 | .0137 | | |
| 6,000 | .0152 | .0001 | |
| 6,500 | .0160 | | |
| 7,000 | .0172 | .0002 | |
| 7,500 | .0183 | | |
| 8,000 | .0194 | .0005 | |
| 8,500 | .0207 | | |
| 9,000 | .0220 | .0007 | |
| 9,500 | .0230 | | |
| 10,000 | .0242 | .0008 | |
| 10,500 | .0257 | | |
| 11,000 | .0267 | .0012 | |
| 11,500 | .0299 | | |
| 12,000 | .0294 | .0014 | |
| 12,500 | .0304 | | |
| 13,000 | .0317 | .0017 | |
| 13,500 | .0332 | | |
| 14,000 | .0344 | .0022 | |
| 14,500 | .0357 | | |
| 15,000 | .0372 | .0027 | |
| 15,500 | .0387 | | |
| 16,000 | .0400 | .0032 | |
| 17,000 | .0427 | | |
| 18,000 | .0454 | .0042 | |
| 19,000 | .0487 | | |
| 20,000 | .0520 | .0062 | |
| 21,000 | .0554 | | |
| 22,000 | .0592 | .0084 | |
| 23,000 | .0630 | | |
| 24,000 | .0672 | .0120 | |
| 29,600 | | | Ultimate strength. |

*Tensile test of riveted joint in white-oak tanned hose leather.*

Section of 3″ hose cut apart and joint tested.

No. 324.




Gross sectional area of leather, 1.17 square inch.
Ten rivets about 2″ diameter.

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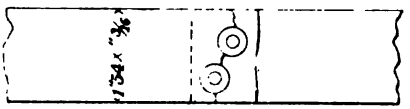
Galvanized rivets and burrs.
Ultimate strength, 3,100 pounds = 2,650 pounds per square inch on gross section.
Fractured first through middle sections of joint.
Fracture occurring on side of joint having burrs.
Heads of rivets cup-shaped; burrs flat.

No. 325.

Specimen made from same leather as No. 324.



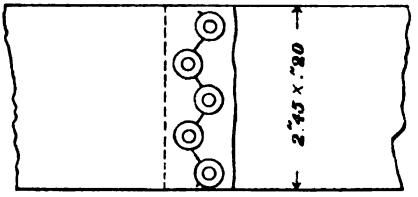
Two rivets, with flat heads and flat burrs.
Galvanized rivets and burrs.
Ultimate strength, 640 pounds.
Fractured leather next rivet heads.
Fractures began at rivet holes.

No. 326.

Two rivets, with cup shaped heads and burrs.
Galvanized rivets.
Ultimate strength, 670 pounds.
Fractures began at rivet holes.
Tore leather on burr side of specimen.

No. 611.

Old specimen of leather hose.



Five rivets, about ".21 diameter, copper, galvanized.
Leather about rivets coated with verdigris.
Ultimate strength, 1,280 pounds = 256 pounds per rivet.
Fractured on the burr side of joint, beginning at middle of specimen.

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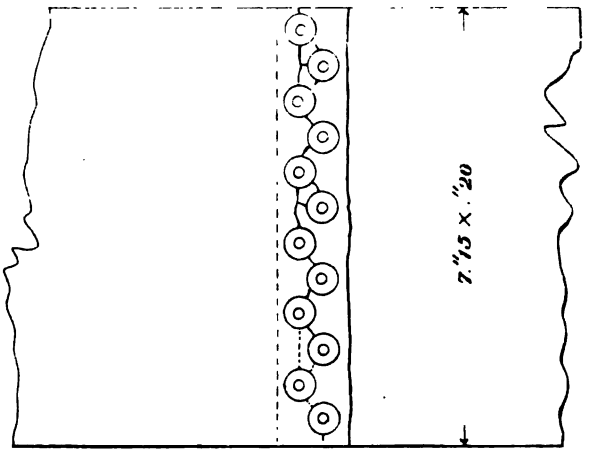
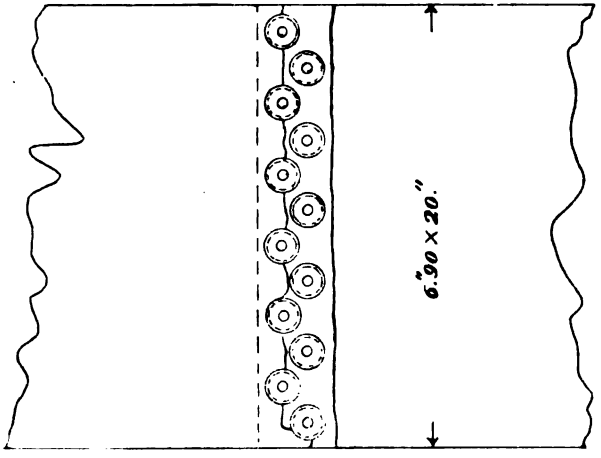
No. 612.

New specimen of leather hose.




Twelve rivets, with flat heads and flat burrs.
Rivets and burrs copper, galvanized.
Ultimate strength, 4,050 pounds = 337 pounds per rivet.
Fractures began at each side, on the burr side tearing across four rivet holes.
Opposite side of joint tearing across nine rivet holes.

No. 613.




Twelve copper rivets, with cup-shaped heads and cup-shaped burrs; heads galvanized.
Copper burrs not galvanized.
Ultimate strength, 4,210 pounds = 351 pounds per rivet.
Fractured across specimen through one row of rivet holes on the burr side of the joint.

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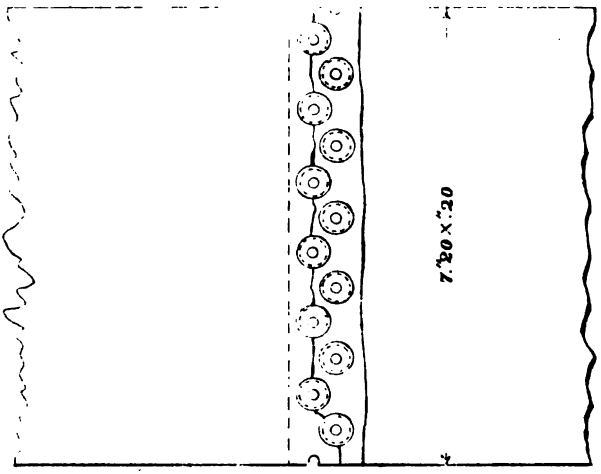
No. 614.




Twelve copper rivets, with cup-shaped heads and burrs.
Rivets galvanized, burrs made of brass, not galvanized.
Ultimate strength, 4,380 pounds = 365 pounds per rivet.
Specimen fractured on the side of the rivet heads, the fracture beginning at one edge and tearing across through one row of rivet holes.
Specimens Nos. 612, 613, and 614 made from the same piece of leather.

*Compression of cast iron.*

DESCRIPTION OF CASTINGS.

. indicates Providence gun iron, dry sand slack heating.
. . indicates Providence gun iron, dry sand hot.
. . . indicates gray iron, dry sand.
. . . . indicates gray iron, wet sand.
Bars cylindrical, in the condition they came from the molds, ends faced off.
Tested between flat steel faces.

No. 363.

Mark on bar, .
Length, 14″.95.
Diameter, 1″.75.
Sectional area, 2.4 square inches.
Ultimate strength, 149,209 pounds = 62,170 pounds per square inch.

No. 364.

Mark on bar, . .
Length, 14.″97.
Diameter, 1″.77.
Sectional area, 2.46 square inches.
Ultimate strength, 167,400 pounds = 68,050 pounds per square inch.

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No. 365.

Mark on bar, . . .

Length, 13″.98.
Diameter, 1″.75.
Sectional area, 2.4 square inches.
Ultimate strength, 158,000 pounds = 65,830 pounds per square inch.

No. 366.

Mark on bar, . . . .

Length, 14″.97.
Diameter, 1″.76.
Sectional area, 2.43 square inches.
Ultimate strength, 198,000 pounds = 81,810 pounds per square inch.

*Indentation of copper with circular indenting tool.*

[Three cuts made in each copper.]

| Number of experiment. | Mark on copper. | Size of copper. | | | Pounds pressure on indenting tool. | Length of cut. | Mean length of cut. | Remarks. |
|---|---|---|---|---|---|---|---|---|
| | | Length. | Width. | Thickness. | | | | |
| | | *Inch.* | *Inch.* | *Inch.* | | *Inch.* | *Inch.* | |
| 367 | A | .94 | 1.6 | .48 | 500 | .50— | .497 | |
| | | | | | 500 | .49 | | |
| | | | | | 500 | .50— | | |
| 368 | B | .94 | 1.6 | .48 | 750 | .58½ | .583 | |
| | | | | | 750 | .58 | | |
| | | | | | 750 | .58½ | | |
| 369 | C | .96 | 1.6 | .48 | 1,000 | .64½ | .64 | |
| | | | | | 1,000 | .63½ | | |
| | | | | | 1,000 | .64 | | |
| 370 | D | 1.04 | 1.6 | .48 | 1,250 | .71 | .705 | |
| | | | | | 1,250 | .70— | | |
| | | | | | 1,250 | .70½ | | |
| 371 | E | 1.10 | 1.6 | .48 | 1,500 | .75 | .743 | Perceptible swelling of the sides of coppers. |
| | | | | | 1,500 | .73 | | |
| | | | | | 1,500 | .75— | | |
| 372 | F | 1.23 | 1.6 | .48 | 2,000 | .84½ | .84 | |
| | | | | | 2,000 | .83½ | | |
| | | | | | 2,000 | .84 | | |
| 373 | H | 1.43 | 1.6 | .48 | 2,500 | .90½ | .898 | |
| | | | | | 2,500 | .89 | | |
| | | | | | 2,500 | .90 | | |
| 374 | G | 1.44 | 1.6 | .48 | 3,000 | .98 | .963 | |
| | | | | | 3,000 | .95 | | |
| | | | | | 3,000 | .96 | | |
| 375 | I | 1.52 | 1.6 | .48 | 3,500 | 1.02 | 1.01+ | |
| | | | | | 3,500 | 1.00 | | |
| | | | | | 3,500 | 1.02 | | |
| 376 | J | 1.52 | 1.6 | .48 | 4,000 | 1.08½ | 1.07½ | |
| | | | | | 4,000 | 1.06 | | |
| | | | | | 4,000 | 1.08 | | |
| 377 | K | 1.54 | 1.6 | .48 | 4,500 | 1.12½ | 1.117 | |
| | | | | | 4,500 | 1.10— | | |
| | | | | | 4,500 | 1.12½ | | |
| 378 | L | 1.69 | 1.6 | .48 | 5,000 | 1.17½ | 1.163 | |
| | | | | | 5,000 | 1.14½ | | |
| | | | | | 5,000 | 1.17— | | |
| 379 | M | 1.84 | 1.6 | .48 | 6,000 | 1.25 | 1.23 | |
| | | | | | 6,000 | 1.21 | | |
| | | | | | 6,000 | 1.23 | | |
| 380 | N | 1.90 | 1.6 | .48 | 7,000 | 1.31 | 1.293 | |
| | | | | | 7,000 | 1.27½ | | |
| | | | | | 7,000 | 1.29½ | | |
| 381 | O | 1.99 | 1.6 | .48 | 8,000 | 1.37½ | 1.355 | |
| | | | | | 8,000 | 1.33½ | | |
| | | | | | 8,000 | 1.35½ | | |

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The lengths are recorded in the order they were made. The cuts were spaced so as to divide the width of each copper into four equal (or nearly so) parts.

An outside cut was made first, then the middle cut, and finally an outside cut.

### REMARKS ON THE COMPRESSION TESTS OF TIMBER POSTS.

Posts were tested in a horizontal position between flat cast-iron platforms. Those of rectangular cross-section were placed in the testing-machine with their longer sides vertical.

The vertical dimension is recorded in the notes as depth of post; the horizontal dimension, width of post.

To insure straightness the sticks were dressed immediately before testing. Such as were found badly warped before dressing were measured, and the amount of deflection recorded on the sketches. The letter *c* in connection with figures shows how much the stick was concave on that side. The letter *x* shows that the side to which it refers was convex before dressing. It was intended to determine whether the distortion of seasoning fixed the direction of deflection when tested as a post.

The deflections while under test were indicated by a pointer secured to the middle of the post and having an arm about 24″ long, reaching out to a dial secured to one of the main screws of the testing-machine.

It was observed that many sticks took an apparent deflection in the direction parallel to their longer side. This led to the employment of a pointer about 48″ long, which was secured at its middle to the post.

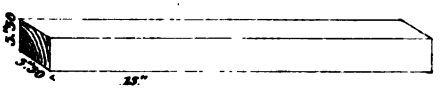
Readings taken on each side showed that the posts frequently had a spiral movement when loaded.

Compressions were measured within the gauged length. The ends of the measuring rods were secured in center punch-marks in the heads of screws driven in the wood.

The direction of the rings of yearly growth are correctly represented on the sketches of the specimens.

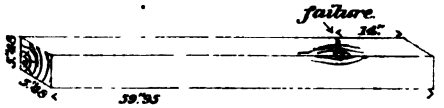
### COMPRESSION TESTS OF WHITE-PINE POSTS.

No. 511.



Weight, 7 pounds.
Sectional area, 30.25 square inches.
Ultimate strength, 108,000 pounds = 3,570 pounds per square inch.
Fibers crushed at middle of block.

No. 491.




Weight, 26½ pounds.
Sectional area, 30 square inches.
Gauged length, 50″.

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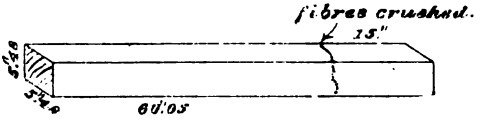
| Loads applied. | Pounds per square inch. | Compression. | Permanent set. | Remarks. |
|---|---|---|---|---|
| *Pounds.* | | *Inch.* | *Inch.* | |
| 3,000 | 100 | 0. | | |
| 15,000 | 500 | .0145 | | |
| 3,000 | 100 | | .0005 | |
| 30,000 | 1,000 | .0340 | | |
| 3,000 | 100 | | .0 | |
| 45,000 | 1,500 | .0540 | | |
| 3,000 | 100 | | .0003 | |
| 60,000 | 2,000 | .0738 | | |
| 3,000 | 100 | | .0 | |
| 111,000 | 3,700 | | | Ultimate strength. |

Failed suddenly by the fibers crushing at a knot $1\frac{3}{4}''$ diameter $14''$ from end of post.

No. 492.

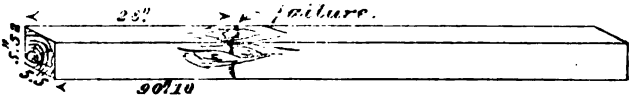



Weight, 31 pounds.
Sectional area, 30 square inches.
Gauged length, $50''$.

| Loads applied. | Pounds per square inch. | Compression. | Permanent set. | Remarks. |
|---|---|---|---|---|
| *Pounds.* | | *Inch.* | *Inch.* | |
| 3,000 | 100 | 0. | | Post free from knots. |
| 15,000 | 500 | .0195 | | |
| 3,000 | 100 | | 0. | |
| 30,000 | 1,000 | .0450 | | |
| 3,000 | 100 | | .0005 | |
| 45,000 | 1,500 | .0708 | | |
| 3,000 | 100 | | .0010 | |
| 60,000 | 2,000 | .0962 | | |
| 3,000 | 100 | | .0015 | |
| 99,300 | 3,310 | | | Ultimate strength. |

Failed suddenly by the fibers crushing $15''$ from end of stick.

No. 493.




Weight, $43\frac{1}{2}$ pounds.
Sectional area, 30.4 square inches.
Gauged length, $50''$.

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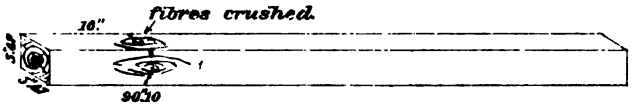
| Loads applied. | Pounds per square inch. | Compression. | Permanent set. | Remarks. |
|---|---|---|---|---|
| *Pounds.* | | *Inch.* | *Inch.* | |
| 3,040 | 100 | 0. | | This stick contains 12 knots from ¾″ to 2½″ diameter. |
| 15,200 | 500 | .0280 | | |
| 3,040 | 100 | | .0010 | |
| 30,400 | 1,000 | .0639 | | |
| 3,040 | 100 | | .0020 | |
| 45,600 | 1,500 | .1020 | | |
| 3,040 | 100 | | .0035 | |
| 60,800 | 2,000 | .1580 | | |
| 3,040 | 100 | | .0122 | |
| 67,400 | 2,217 | | | Ultimate strength. |

Fibers crushed and longitudinal seams opened 28″ from end of stick, in the vicinity of several knots.

No. 494.

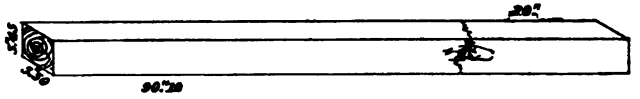



Weight, 37½ pounds.
Sectional area, 29.9 square inches.
Gauged length, 50″.

| Loads applied. | Pounds per square inch. | Compression. | Permanent set. | Remarks. |
|---|---|---|---|---|
| *Pounds.* | | *Inch.* | *Inch.* | |
| 2,990 | 100 | 0. | | Stick contains eleven knots, 1″ diameter. |
| 14,950 | 500 | .0150 | | |
| 2,990 | 100 | | 0. | |
| 29,900 | 1,000 | .0340 | | |
| 2,990 | 100 | | .0002 | |
| 44,850 | 1,500 | .0535 | | |
| 2,990 | 100 | | .0005 | |
| 59,800 | 2,000 | .0748 | | |
| 2,990 | 100 | | .0010 | |
| 70,800 | 2,368 | | | Ultimate strength. |

Failed at five knots 16″ from end.

No. 495.



Weight, 45 pounds.
Sectional area, 29.8 square inches.
Ultimate strength, 74,100 pounds = 2,487 pounds per square inch.
Failed from 20″ to 25″ from end where the stick was cross-grained and had some knots.



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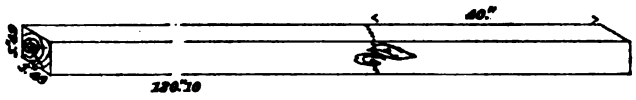
No. 512.

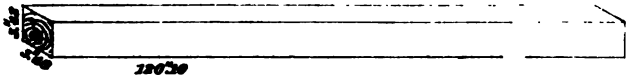



Weight, 62½ pounds.
Sectional area, 30.1 square inches.
Gauged length, 100″.
Not counterweighted.

| Loads applied. | Pounds per square inch. | Compression. | Permanent set. | Deflections. | | Remarks. |
|---|---|---|---|---|---|---|
| | | | | Horizontal. | Vertical. | |
| *Pounds.* | | *Inch.* | *Inch.* | *Inch.* | *Inch.* | |
| 3,010 | 100 | 0. | ..... | 0. | 0. | |
| 15,050 | 500 | .0345 | ..... | .01 | 0. | |
| 3,010 | 100 | ..... | 0. | 0. | 0. | |
| 30,100 | 1,000 | .0775 | ..... | .03 | —.05 | |
| ..... | 100 | ..... | .0008 | 0. | 0. | |
| 45,150 | 1,500 | .1206 | ..... | .07 | —.08 | |
| ..... | 100 | ..... | .0013 | 0. | 0. | |
| 60,200 | 2,000 | .1655 | ..... | .10 | —.10 | |
| ..... | 100 | ..... | .0025 | 0. | —.01 | |
| 70,000 | ..... | ..... | ..... | .07 | —.12 | |
| 80,000 | ..... | ..... | ..... | .17 | —.18 | |
| 82,000 | 2,724 | ..... | ..... | ..... | ..... | Ultimate strength. |

Failed at some knots 40″ from end. Maximum deflection occurred at this point.

No. 519.



Sectional area, 29.7 square inches.
Gauged length, 100″.
Weight, 49½ pounds.
Not counterweighted.

| Loads applied. | Pounds per square inch. | Compression. | Permanent set. | Deflections. | | Remarks. |
|---|---|---|---|---|---|---|
| | | | | Horizontal. | Vertical. | |
| *Pounds.* | | *Inch.* | *Inch.* | *Inch.* | *Inch.* | |
| 2,970 | 100 | 0. | ..... | 0. | 0. | |
| 14,850 | 500 | .0325 | ..... | 0. | 0. | |
| ..... | 100 | ..... | —.0006 | 0. | 0. | |
| 29,700 | 1,000 | .0765 | ..... | 0. | 0. | |
| ..... | 100 | ..... | —.0004 | 0. | 0. | |
| 44,550 | 1,500 | .1220 | ..... | 0. | 0. | |
| ..... | 100 | ..... | —.0004 | 0. | 0. | |
| 75,400 | 2,539 | ..... | ..... | ..... | ..... | Ultimate strength. |

Failed at some knots near middle of stick. Deflecting sideways.

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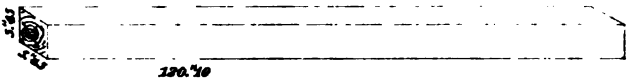
No. 520.

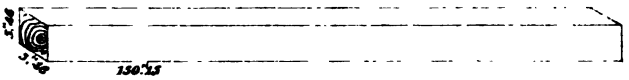


Sectional area, 29.7 square inches.
Gauged length, 100″.
Weight, 59½ pounds.

| Loads applied. | Pounds per square inch. | Compression. | Permanent set. | Deflections. | | Remarks. |
|---|---|---|---|---|---|---|
| | | | | Horizontal. | Vertical. | |
| *Pounds.* | | *Inch.* | *Inch.* | *Inch.* | *Inch.* | |
| 2,970 | 100 | 0. | ..... | 0. | 0. | |
| 14,850 | 500 | .0350 | ..... | 0. | 0. | |
| ..... | 100 | ..... | .0005 | 0. | 0. | |
| 29,700 | 1,000 | .0770 | ..... | 0. | .04 | |
| ..... | 100 | ..... | .0007 | 0. | 0. | |
| 44,550 | 1,500 | .1210 | ..... | 0. | .08 | |
| ..... | 100 | ..... | .0015 | 0. | 0. | |
| 61,700 | 2,077 | ..... | ..... | —.06 | .15 | Ultimate strength. |

Failed at some knots 30″ from end.

No. 516.



Sectional area, 29.8 square inches.
Gauged length, 100″.
Weight, 60 pounds.
Counterweight at middle, 30 pounds.

| Loads applied. | Pounds per square inch. | Compression. | Permanent set. | Deflections. | | Remarks. |
|---|---|---|---|---|---|---|
| | | | | Horizontal. | Vertical. | |
| *Pounds.* | | *Inch.* | *Inch.* | *Inch.* | *Inch.* | |
| 2,980 | 100 | 0. | 0. | 0. | 0. | |
| 14,900 | 500 | .0195 | ..... | —.04 | —.01 | |
| ..... | 100 | ..... | .0010 | 0. | 0. | |
| 29,800 | 1,000 | .1015 | ..... | —.10 | —.06 | |
| ..... | 100 | ..... | .0020 | 0. | .0 | |
| 44,700 | 1,500 | .1602 | ..... | —.15 | —.09 | |
| ..... | 100 | ..... | .0030 | 0. | —.01 | |
| 59,600 | 2,000 | ..... | ..... | —.25 | —.12 | |
| 68,000 | 2,282 | ..... | ..... | ..... | ..... | Ultimate strength. |

Failed at a group of knots 64″ from end.

This post had groups of knots at intervals along its length of 18″ to 24″. The failure occurred at the third group from the end.

Post now sawed apart and a block (No. 516¹, 12″ long) obtained free from knots, also a block (No. 516², 12″ long) containing a group of knots. Their ultimate compression strength obtained as below.

Blocks tested seven days after original test.

Block No. 516¹ (free from knots): Ultimate strength, 101,900 pounds = 3,420 pounds per square inch.

Block No. 516² (contains seven knots from ½″ to 1″ diameter): Ultimate strength, 89,500 pounds = 3,003 pounds per square inch.

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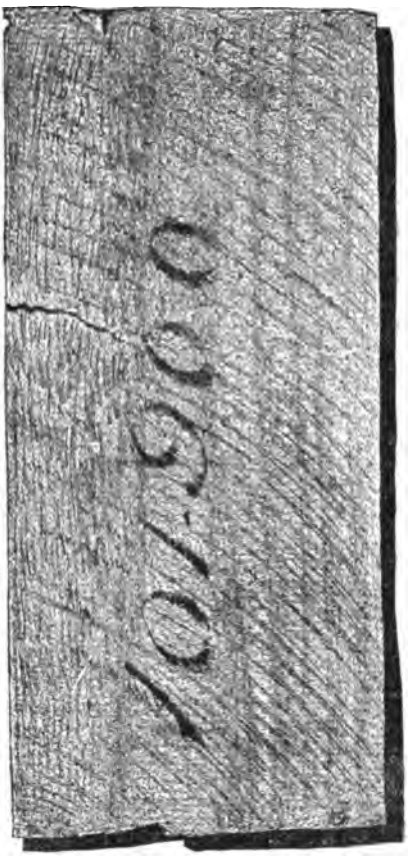
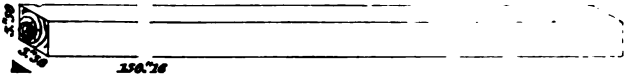
BLOCK No. 516¹.



BLOCK No. 516².

## No. 517.



Sectional area, 30.25 square inches.
Weight, 70 pounds.
Counterweight at middle, 35 pounds.
Gauged length, 100″.

| Loads applied. | Pounds per square inch. | Compression. | Permanent set. | Deflections. Horizontal. | Deflections. Vertical. | Remarks. |
|---|---|---|---|---|---|---|
| *Pounds.* | | *Inch.* | *Inch.* | *Inch.* | *Inch.* | |
| 3,025 | 100 | 0. | 0. | 0. | 0. | |
| 15,125 | 500 | .1340 | ..... | 0. | 0. | |
| ..... | 100 | ..... | 0. | 0. | 0. | |
| 30,250 | 1,000 | .0760 | ..... | —.05 | 0. | |
| ..... | 100 | ..... | 0. | 0. | 0. | |
| 45,375 | 1,500 | .1200 | ..... | —.10 | 0. | |
| ..... | 100 | ..... | .0005 | 0. | 0. | |
| 60,500 | 2,000 | ..... | ..... | —.14 | 0. | |
| 70,800 | 2,340 | ..... | ..... | ..... | ..... | Ultimate strength. |

Failed at a group of knots 58″ from end.

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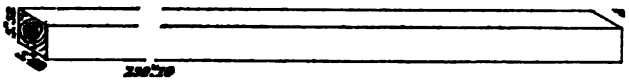
No. 518.

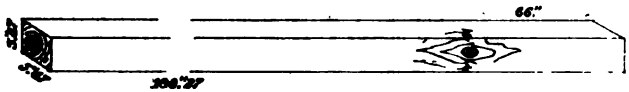


Sectional area, 30.25 square inches.
Weight, 67½ pounds.
Gauged length, 100″.
Counterweight at middle, 34 pounds.

| Loads applied. | Pounds per square inch. | Compression. | Permanent set. | Deflections. | | Remarks. |
|---|---|---|---|---|---|---|
| | | | | Horizontal. | Vertical. | |
| *Pounds.* | | *Inch.* | *Inch.* | *Inch.* | *Inch.* | |
| 3, 025 | 100 | 0. | | 0. | 0. | |
| 15, 125 | 500 | .0272 | | 0. | 0. | |
| | 100 | | 0. | 0. | 0. | |
| 30, 250 | 1, 000 | .0625 | | 0. | 0. | |
| | 100 | | .0010 | 0. | 0. | |
| 45, 375 | 1, 500 | .0980 | | 0. | .05 | |
| | 100 | | .0010 | 0. | 0. | |
| 60, 500 | 2, 000 | | | 0. | .10 | |
| 100, 000 | 3, 306 | | | 0. | .12 | Ultimate strength. |

Failed at a group of knots 31″ from end.

No. 513.




Sectional area, 29.9 square inches.
Gauged length, 100″.
Weight, 84½ pounds.

| Loads applied. | Pounds per square inch. | Compression. | Permanent set. | Deflections. | | Remarks. |
|---|---|---|---|---|---|---|
| | | | | Horizontal. | Vertical. | |
| *Pounds.* | | *Inch.* | *Inch.* | *Inch.* | *Inch.* | |
| 2, 990 | 100 | 0. | 0. | 0. | 0. | |
| 14, 950 | 500 | .0300 | | 0. | 0. | |
| | 100 | | | | | |
| 29, 900 | 1, 000 | .0675 | | — .01 | .10 | |
| | 100 | | 0. | 0. | 0. | |
| 44, 850 | 1, 500 | .0950 | | — .06 | .29 | |
| | 100 | | — .0010 | + .04 | — .04 | |
| 54, 000 | 1, 806 | | | | | Ultimate strength. |

Failed at a group of knots 66″ from end, deflecting sideways and upward.

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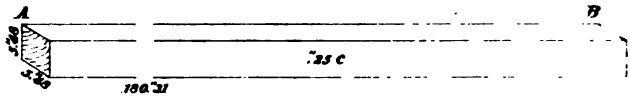
No. 514.

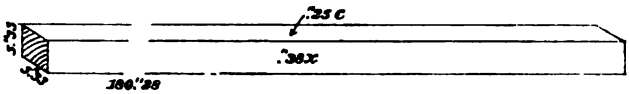



Sectional area, 30 square inches.
Gauged length, 100″.
Weight, 90 pounds.
Counterweight at middle, 45 pounds.
Initial bend before dressing down from size, 6″×6″: Horizontal, +″.25.

| Loads applied. | Pounds per square inch. | Compression. | Permanent set. | Deflections. | | Remarks. |
|---|---|---|---|---|---|---|
| | | | | Horizontal. | Vertical. | |
| *Pounds.* | | *Inch.* | *Inch.* | *Inch.* | *Inch.* | |
| 6,000 | 200 | 0. | ..... | 0. | 0. | |
| 15,000 | 500 | .0158 | ..... | 0. | 0. | |
| ..... | 200 | ..... | 0. | 0. | 0. | |
| 30,000 | 1,000 | .0420 | ..... | 0. | 0. | |
| ..... | 200 | ..... | 0. | 0. | 0. | |
| 45,000 | 1,500 | ..... | ..... | 0. | 0. | |
| 60,000 | 2,000 | ..... | ..... | 0. | .05 | |
| 75,000 | 2,500 | ..... | ..... | .02 | .11 | |
| 90,000 | 3,000 | ..... | ..... | .09 | .28 | |
| 93,500 | 3,117 | ..... | ..... | ..... | ..... | Ultimate strength. |

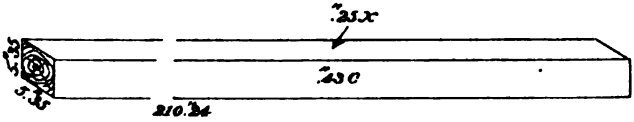
Failed by deflecting upward and sideways.
Fibers crushing at some knots 14″ from end *A*, and at some knots 24″ from end *B*.

No. 515.




Sectional area, 28.4 square inches.
Gauged length, 100″.
Weight, 91 pounds.
Counterweight at middle, 45 pounds.
Initial bend in post before dressing down from size 6″×6″: Horizontal, —″.38; vertical, —″.25.

No. 521.




Sectional area, 28.6 square inches.
Weight, 96½ pounds.
Counterweight at middle, 48 pounds.
Initial bends in stick before dressing down from size 6″×6″: Horizontal, +″.43; vertical, +″.25.

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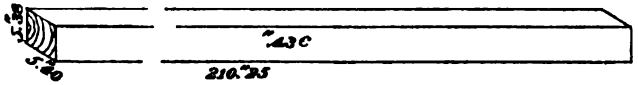
| Loads applied. | Deflections. | | Remarks. |
|---|---|---|---|
| | Horizontal. | Vertical. | |
| *Pounds.* | *Inch.* | *Inch.* | |
| 2,000 | 0. | —.13 | |
| 4,000 | 0. | —.13 | |
| 6,000 | 0. | —.11 | |
| 8,000 | 0. | —.10 | |
| 10,000 | 0. | —.10 | |
| 12,000 | 0. | —.10 | |
| 14,000 | 0. | —.10 | |
| 16,000 | .02 | —.10 | |
| 18,000 | .03 | —.09 | |
| 20,000 | .04 | —.08 | |
| 22,000 | .05 | —.07 | |
| 24,000 | .07 | —.07 | |
| 26,000 | .09 | —.07 | |
| 28,000 | .10 | —.07 | |
| 30,000 | .11 | —.06 | |
| 32,000 | .12 | —.06 | |
| 34,000 | .14 | —.05 | |
| 36,000 | .16 | —.05 | |
| 38,000 | .18 | —.05 | |
| 40,000 | .20 | —.05 | |
| 42,000 | .24 | —.05 | |
| 44,000 | .28 | —.05 | |
| 48,000 | .44 | —.07 | |
| 50,000 | .55 | —.10 | |
| 52,000 | .90 | —.20 | |
| 53,000 | 1.27 | —.40 | Ultimate strength = 1,858 pounds per square inch. |

Deflected sideways and downward.
Crushed fibers in vicinity of small knots ($\frac{1}{2}$″ diameter) at middle.

No. 522.



Sectional area, 29 square inches.
Weight, 101 pounds.
Counterweight at middle, 50 pounds.
Initial deflection in stick before dressing down from size 6″×6″: Horizontal, + ″.43.

| Loads applied. | Deflections. | | Remarks. |
|---|---|---|---|
| | Horizontal. | Vertical. | |
| *Pounds.* | *Inch.* | *Inch.* | |
| 2,000 | 0. | —.15 | |
| 4,000 | 0. | —.15 | |
| 6,000 | 0. | —.16 | |
| 8,000 | 0. | —.16 | |
| 10,000 | 0. | —.17 | |
| 12,000 | 0. | —.17 | |
| 14,000 | 0. | —.17 | |
| 16,000 | 0. | —.18 | |
| 18,000 | 0. | —.19 | |
| 20,000 | 0. | —.20 | |
| 22,000 | 0. | —.21 | |
| 24,000 | 0. | —.24 | |
| 26,000 | 0. | —.26 | |
| 28,000 | 0. | —.29 | |
| 30,000 | 0. | —.32 | |
| 32,000 | 0. | —.38 | |
| 34,000 | —.02 | —.45 | |
| 36,000 | —.03 | —.52 | |
| 38,000 | —.06 | —.72 | |
| 40,000 | —.14 | —1.05 | |
| 40,500 | —.14 | —1.48 | Ultimate strength = 1,396 pounds per square inch. |

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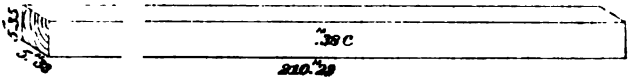
Deflected sideways and downward, opening seam (wind shake) on concave side.

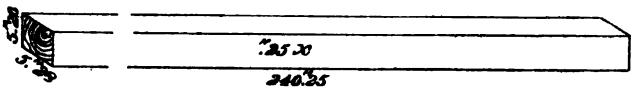
No. 523.



Sectional area, 28.5 square inches.
Weight, 95 pounds.
Counterweight at middle, 47 pounds.
Initial deflection before dressing down from size 6″ × ″6: Horizontal, + ″.38.

| Loads applied. | Deflections. | | Remarks. |
|---|---|---|---|
| | Horizontal. | Vertical. | |
| *Pounds.* | *Inch.* | *Inch.* | |
| 2,000 | + .06 | — .11 | |
| 4,000 | .09 | — .07 | |
| 6,000 | .09 | — .04 | |
| 8,000 | .09 | — .03 | |
| 10,000 | .09 | — .01 | |
| 12,000 | .09 | 0. | |
| 14,000 | .09 | 0. | |
| 16,000 | .09 | .01 | |
| 18,000 | .10 | .01 | |
| 20,000 | .10 | .01 | |
| 22,000 | .11 | .01 | |
| 24,000 | .12 | .01 | |
| 26,000 | .13 | .01 | |
| 28,000 | .14 | .01 | |
| 30,000 | .15 | .01 | |
| 34,000 | .17 | .01 | |
| 38,000 | .20 | .01 | |
| 42,000 | .24 | .01 | |
| 46,000 | .29 | 0. | |
| 50,000 | .36 | — .02 | |
| 54,000 | .47 | — .05 | |
| 60,000 | .70 | — .19 | |
| 64,000 | 1.19 | — .50 | |
| 64,800 | ..... | ..... | Ultimate strength = 2,274 pounds per square inch. |

No. 524.



Sectional area, 27.8 square inches.
Weight, 109½ pounds.
Counterweight at middle, 55 pounds.
Initial deflection of stick before dressing down from original size 6″ × ″6: Horizontal, — ″.25.
Seven knots in post, from ¾″ to 1¼″ diameter.

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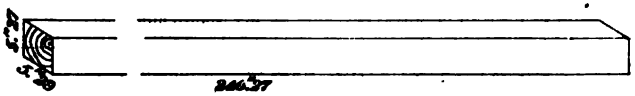
| Loads applied. | Deflections. | | Remarks. |
|---|---|---|---|
| | Horizontal. | Vertical. | |
| *Pounds.* | *Inch.* | *Inch.* | |
| 2,000 | .0 | .0 | |
| 4,000 | —.04 | .0 | |
| 6,000 | —.06 | —.02 | |
| 8,000 | —.08 | —.04 | |
| 10,000 | —.10 | —.06 | |
| 12,000 | —.12 | —.08 | |
| 14,000 | —.14 | —.10 | |
| 16,000 | —.16 | —.13 | |
| 18,000 | —.18 | —.16 | |
| 20,000 | —.19 | —.19 | |
| 22,000 | —.21 | —.22 | |
| 24,000 | —.22 | —.26 | |
| 26,000 | —.25 | —.29 | |
| 28,000 | —.26 | —.33 | |
| 30,000 | —.29 | —.38 | |
| 32,000 | —.32 | —.42 | |
| 34,000 | —.35 | —.50 | |
| 36,000 | —.40 | —.60 | |
| 38,000 | —.44 | —.68 | |
| 40,000 | —.51 | —.82 | |
| 42,000 | —.62 | 1.04 | |
| 44,000 | —.79 | 1.30 | |
| 45,000 | 1.30 | 1.20 | Ultimate strength = 1,619 pounds per square inch. |

Fibers crushed at knot near middle of post.

No. 525.



Sectional area, 27.9 square inches.
Weight, 106½ pounds.
Counterweight at middle, 53 pounds.

| Loads applied. | Deflections. | | Remarks. |
|---|---|---|---|
| | Horizontal. | Vertical. | |
| *Pounds.* | *Inch.* | *Inch.* | |
| 2,000 | .04 | —.17 | |
| 4,000 | .04 | —.17 | |
| 6,000 | .04 | —.19 | |
| 8,000 | .04 | —.20 | |
| 10,000 | .04 | —.21 | |
| 12,000 | .06 | —.22 | |
| 14,000 | .07 | —.24 | |
| 16,000 | .10 | —.26 | |
| 18,000 | .12 | —.28 | |
| 20,000 | .14 | —.30 | |
| 22,000 | .17 | —.33 | |
| 24,000 | .20 | —.36 | |
| 24,000 | .20 | —.36 | Sustained load 5 minutes. |
| 26,000 | .24 | —.40 | |
| 28,000 | .30 | —.45 | |
| 30,000 | .36 | —.50 | |
| 32,000 | .45 | —.58 | |
| 34,000 | .55 | —.66 | |
| 36,000 | .73 | —.80 | |
| 38,000 | .96 | —1.00 | |
| 39,500 | 1.70 | —1.60 | Ultimate strength = 1,416 pounds per square inch. |

Failed at two knots (¾″ × 1½″ diameter) at middle of post.

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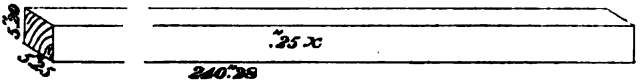
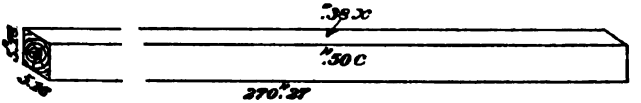
No. 526.




Sectional area, 27.8 square inches.
Weight, 95 pounds.
Counterweight at middle, 47 pounds.
Initial deflection in stick before dressing down from size 6″ × 6″: Horizontal, — ″.25.

| Loads applied. | Deflections. | | Remarks. |
|---|---|---|---|
| | Horizontal. | Vertical. | |
| *Pounds.* | *Inch.* | *Inch.* | |
| 2,000 | — .05 | 0. | |
| 4,000 | — .05 | 0. | |
| 6,000 | — .05 | 0. | |
| 8,000 | — .04 | 0. | |
| 10,000 | — .03 | 0. | |
| 12,000 | — .03 | .01 | |
| 14,000 | — .03 | .01 | |
| 16,000 | — .02 | .02 | |
| 18,000 | — .01 | .03 | |
| 20,000 | 0. | .04 | |
| 22,000 | 0. | .05 | |
| 24,000 | 0. | .05 | |
| 26,000 | .01 | .06 | |
| 28,000 | .03 | .07 | |
| 30,000 | .05 | .08 | |
| 32,000 | .09 | .10 | |
| 34,000 | .14 | .10 | |
| 36,000 | .27 | .10 | |
| 37,000 | 1.88 | .80 | Ultimate strength = 1,331 pounds per square inch. |

No. 505.




Weight, 110 pounds.
Counterweight at middle, 55 pounds.
Sectional area, 26.7 square inches.
Initial bends in post before dressing down from size 6″ × 6″: Horizontal + ″.50; vertical, + ″.38.

| Loads applied. | Deflections. | | Remarks. |
|---|---|---|---|
| | Horizontal. | Vertical. | |
| *Pounds.* | *Inch.* | *Inch.* | |
| 2,000 | .04 | 0. | |
| 4,000 | .04 | .02 | |
| 6,000 | .04 | .06 | |
| 8,000 | .04 | .11 | |
| 10,000 | .04 | .13 | |
| 12,000 | .04 | .15 | |
| 14,000 | + .02 | .16 | |
| 16,000 | .0 | .18 | |
| 18,000 | — .01 | .20 | |
| 20,000 | — .02 | .21 | |
| 22,000 | — .05 | .24 | |
| 24,000 | — .08 | .26 | |
| 26,000 | — .11 | .28 | |
| 28,000 | — .15 | .30 | |
| 30,000 | — .22 | .34 | |
| 32,000 | — .33 | .40 | |
| 34,000 | — .50 | .50 | |
| 36,000 | — .90 | .60 | |
| 37,000 | —2.50 | .90 | Ultimate strength = 1,386 pounds per square inch. |

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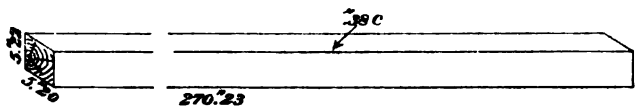
Failed by deflecting sideways and upward. When deflection reached 3″ sideways, the post suddenly sprung, increasing the deflection to 8″.

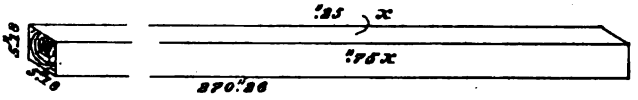
No. 506.



Weight, 113 pounds.
Counterweight at middle, 56 pounds.
Sectional area, 27.1 square inches.
Initial bend before dressing down from size 6″ × 6″: Vertical, —″.38.

| Loads applied. | Deflections. | | Remarks. |
|---|---|---|---|
| | Horizontal. | Vertical. | |
| *Pounds.* | *Inch.* | *Inch.* | |
| 2,000 | 0. | 0. | |
| 4,000 | —.02 | —.02 | |
| 6,000 | —.05 | —.05 | |
| 8,000 | —.08 | —.05 | |
| 10,000 | —.09 | —.06 | |
| 12,000 | —.11 | —.09 | |
| 14,000 | —.14 | —.10 | |
| 16,000 | —.16 | —.11 | |
| 18,000 | —.18 | —.12 | |
| 20,000 | —.21 | —.14 | |
| 22,000 | —.25 | —.15 | |
| 24,000 | —.30 | —.17 | |
| 26,000 | —.34 | —.18 | |
| 28,000 | —.40 | —.20 | |
| 30,000 | —.48 | —.20 | |
| 32,000 | —.58 | —.21 | |
| 34,000 | —.80 | —.20 | |
| 35,000 | —1.05 | —.20 | |
| 36,000 | —1.35 | —.20 | |
| 37,000 | —1.92 | —.20 | |
| 37,200 | | | Ultimate strength = 1,373 pounds per square inch. |

No. 507.



Weight, 118 pounds.
Counter weight at middle, 59 pounds.
Sectional area, 26.8 square inches.
Initial deflection before dressing down from size 6″ × 6″: Horizontal, —″.75; vertical, + ″.25.

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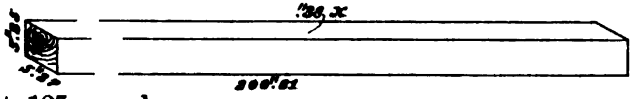
| Loads applied. | Deflections. | | Remarks. |
|---|---|---|---|
| | Horizontal. | Vertical. | |
| *Pounds.* | *Inch.* | *Inch.* | |
| 2,000 | —.19 | .05 | |
| 4,000 | —.11 | .08 | |
| 6,000 | —.10 | .10 | |
| 8,000 | —.09 | .12 | |
| 10,000 | —.08 | .13 | |
| 12,000 | —.08 | .14 | |
| 14,000 | —.09 | .15 | |
| 16,000 | —.10 | .16 | |
| 18,000 | —.10 | .18 | |
| 20,000 | —.12 | .19 | |
| 22,000 | —.14 | .20 | |
| 24,000 | —.15 | .21 | |
| 26,000 | —.16 | .24 | |
| 28,000 | —.20 | .25 | |
| 30,000 | —.22 | .26 | |
| 32,000 | —.27 | .30 | |
| 34,000 | —.30 | .32 | |
| 36,000 | —.35 | .35 | |
| 38,000 | —.42 | .40 | |
| 40,000 | —.50 | .43 | |
| 41,000 | —.58 | .50 | |
| 42,000 | —.66 | .51 | |
| 43,000 | —.78 | .55 | |
| 44,000 | —.98 | .60 | |
| 45,000 | —1.21 | .65 | |
| 46,000 | —1.60 | .70 | |
| 46,700 | —2.40 | .75 | Ultimate strength = 1,743 pounds per square inch. |

No. 502.



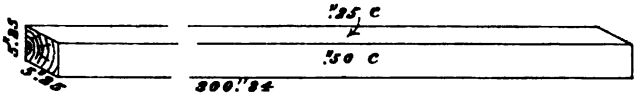
Weight, 127 pounds.
Counterweight at middle, 63 pounds.
Sectional area, 27.7 square inches.
Initial bend in stick before dressing down from size 6″ × 6″: Vertical, + ″.38.

| Loads applied. | Deflections. | | Remarks. |
|---|---|---|---|
| | Horizontal. | Vertical. | |
| *Pounds.* | *Inch.* | *Inch.* | |
| 2,000 | —.17 | .32 | |
| 4,000 | —.17 | .35 | |
| 6,000 | —.17 | .38 | |
| 8,000 | —.20 | .40 | |
| 10,000 | —.22 | .42 | |
| 12,000 | —.24 | .46 | |
| 14,000 | —.27 | .50 | |
| 16,000 | —.30 | .52 | |
| 18,000 | —.34 | .58 | |
| 20,000 | —.37 | .64 | |
| 21,000 | —.40 | .70 | |
| 22,000 | —.42 | .75 | |
| 23,000 | —.46 | .80 | |
| 24,000 | —.50 | .86 | |
| 25,000 | —.54 | .95 | |
| 26,000 | —.60 | 1.03 | |
| 27,000 | —.65 | 1.20 | |
| 28,000 | —.74 | 1.35 | |
| 29,000 | —.87 | 1.60 | |
| 30,000 | —1.08 | 1.98 | |
| 30,900 | —1.48 | 2.70 | Ultimate strength = 1,116 pounds per square inch. |

Failed by deflecting upward and sideways.

Digitized by Google

No. 503.

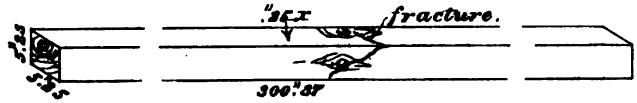



Weight, 125 pounds.
Counterweight at middle, 62 pounds.
Sectional area, 27.6 square inches.
Initial bend in post before dressing down from size 6″ × 6″: Horizontal, +″.50; vertical, — ″.25.

| Loads applied. | Deflections. Horizontal. | Deflections. Vertical. | Remarks. |
|---|---|---|---|
| *Pounds.* | *Inch.* | *Inch.* | |
| 2,000 | + .56 | — .30 | |
| 4,000 | + .56 | — .26 | |
| 6,000 | + .56 | — .25 | |
| 8,000 | .58 | — .24 | |
| 10,000 | .62 | — .25 | |
| 12,000 | .69 | — .26 | |
| 14,000 | .75 | — .27 | |
| 16,000 | .84 | — .29 | |
| 18,000 | .95 | — .31 | |
| 20,000 | 1.10 | — .35 | |
| 21,000 | 1.19 | — .37 | |
| 22,000 | 1.30 | — .40 | |
| 23,000 | 1.40 | — .45 | |
| 24,000 | 1.60 | — .50 | |
| 25,000 | 1.85 | — .60 | |
| 25,800 | ..... | ..... | Ultimate strength = 935 pounds per square inch. |

This post had two knots at middle about 1¾″ diameter each, and corners near middle chipped off ½″ chamfer.
When post passed maximum load and deflected sideways and downward it splintered near middle, in the vicinity of the knots.

No. 504.




Weight, 127 pounds.
Counterweight at middle, 62 pounds.
Sectional area, 27.6 square inches.
Initial bend in post before dressing down from size 6″ × 6″: Vertical, +″.25.

| Loads applied. | Deflections. Horizontal. | Deflections. Vertical. | Remarks. |
|---|---|---|---|
| *Pounds.* | *Inch.* | *Inch.* | |
| 2,000 | + .35 | — .23 | |
| 4,000 | .36 | — .22 | |
| 6,000 | .37 | — .19 | |
| 8,000 | .39 | — .16 | |
| 10,000 | .41 | — .12 | |
| 12,000 | .45 | — .06 | |
| 14,000 | .50 | + .02 | |
| 16,000 | .55 | .14 | |
| 18,000 | .63 | .31 | |
| 20,000 | .79 | .64 | |
| 21,000 | .93 | .95 | |
| 22,000 | 1.24 | 1.60 | |
| 22,200 | ..... | ..... | Ultimate strength = 804 pounds per square inch. |

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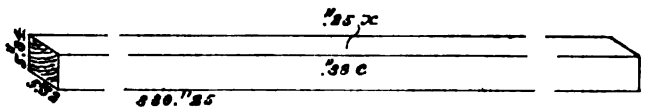
Failed by deflecting sideways and upward.
Sprung suddenly and fractured at some knots near middle.
Oblique fracture.

No. 496.



Weight, 169 pounds.
Counterweight at middle, 85 pounds.
Sectional area, 28.4 square inches.
Before dressing down from 6″×6″ stick, the post was deflected at middle: Horizontal, +″.38; vertical, +″.25, being convex on the heart side.

| Loads applied. | Deflections. | | Remarks. |
|---|---|---|---|
| | Horizontal. | Vertical. | |
| *Pounds.* | *Inch.* | *Inch.* | |
| 1,000 | 0. | 0. | |
| 2,000 | 0. | 0. | |
| 3,000 | .02 | 0. | |
| 4,000 | .02 | 0. | |
| 5,000 | .02 | 0. | |
| 6,000 | .03 | 0. | |
| 7,000 | .05 | .02 | |
| 8,000 | .06 | .04 | |
| 9,000 | .08 | .05 | |
| 10,000 | .09 | .06 | |
| 11,000 | .10 | .08 | |
| 12,000 | .11 | .10 | |
| 13,000 | .13 | .11 | |
| 14,000 | .14 | .12 | |
| 15,000 | .15 | .14 | |
| 16,000 | .17 | .17 | |
| 17,000 | .18 | .20 | |
| 18,000 | .20 | .21 | |
| 19,000 | .22 | .24 | |
| 20,000 | .25 | .27 | |
| 19,000 | .10 | .11 | |
| 20,000 | .25 | .27 | |
| 21,000 | .27 | .30 | |
| 22,000 | .30 | .34 | |
| 23,000 | .35 | .38 | |
| 24,000 | .40 | .41 | |
| 25,000 | .45 | .47 | |
| 26,000 | .50 | .52 | |
| 27,000 | .58 | .58 | |
| 28,000 | .68 | .67 | |
| 29,000 | .80 | .77 | |
| 30,000 | .99 | .93 | |
| 31,000 | 1.20 | 1.12 | |
| 32,000 | 1.70 | 1.60 | |
| 32,500 | | | Ultimate strength = 1,144 pounds per square inch. |

Failed by deflection sideways and upward, taking a sudden spring immediately after the maximum load was reached.
The deflections followed the initial bend the stick had before dressing

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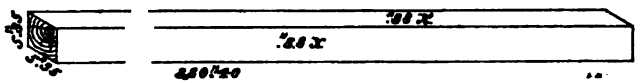
No. 497.

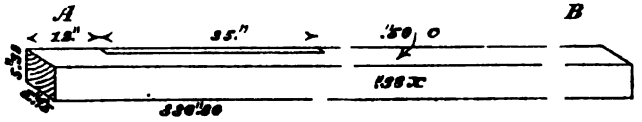


Weight, 173 pounds.
Counterweight at middle, 85 pounds.
Sectional area, 28.6 square inch.
Before dressing down from 6″×6″ stick, post had initial deflection: Horizontal, —″.38; vertical, +″.38.

| Loads applied. | Deflections. | | Remarks. |
|---|---|---|---|
| | Horizontal. | Vertical. | |
| *Pounds.* | *Inch.* | *Inch.* | |
| 1,000 | 0. | 0. | |
| 2,000 | 0. | —.02 | |
| 3,000 | 0. | —.04 | |
| 4,000 | 0. | —.04 | |
| 5,000 | 0. | —.04 | |
| 6,000 | 0. | —.04 | |
| 7,000 | 0. | —.04 | |
| 8,000 | —.02 | —.04 | |
| 9,000 | —.05 | —.04 | |
| 10,000 | —.06 | —.03 | |
| 11,000 | —.07 | —.02 | |
| 12,000 | —.08 | —.01 | |
| 13,000 | —.10 | 0. | |
| 14,000 | —.11 | 0. | |
| 15,000 | —.11 | 0. | |
| 16,000 | —.14 | .01 | |
| 17,000 | —.16 | .03 | |
| 18,000 | —.18 | .04 | |
| 19,000 | —.20 | .05 | |
| 20,000 | —.23 | .07 | |
| 21,000 | —.27 | .09 | |
| 22,000 | —.31 | .11 | |
| 23,000 | —.34 | .14 | |
| 24,000 | —.38 | .16 | |
| 25,000 | —.44 | .18 | |
| 26,000 | —.51 | .22 | |
| 27,000 | —.58 | .28 | |
| 28,000 | —.70 | .32 | |
| 29,000 | —.86 | .40 | |
| 30,000 | —1.06 | .49 | |
| 31,000 | —1.32 | .56 | |
| 32,000 | ..... | ..... | Ultimate strength = 1,119 pounds per square inch. |

Failed by deflection sideways and upward, following the initial direction of the bends in the upward movement and contrary to the sideways initial bend.

No. 498.




Weight, 157 pounds.
Sectional area, 28.6 square inches.
Counter weight at middle, 78 pounds.
Initial bend in post before dressing down from 6″×6″ square: Horizontal, —″.38; vertical, —″.50. Piece 5″.35×″.70×″.35 set in end *A* 12″ from end of stick.

Digitized by Google

| Loads applied. | Deflections. | | Remarks. |
|---|---|---|---|
| | Horizontal. | Vertical. | |
| *Pounds.* | *Inch.* | *Inch.* | |
| 1,000 | 0. | 0. | |
| 2,000 | 0. | 0. | |
| 3,000 | 0. | + .01 | |
| 4,000 | 0. | .02 | |
| 5,000 | 0. | .04 | |
| 6,000 | — .01 | .05 | |
| 7,000 | — .02 | .07 | |
| 8,000 | — .02 | .08 | |
| 9,000 | — .03 | .09 | |
| 10,000 | — .04 | .10 | |
| 11,000 | — .04 | .11 | |
| 12,000 | — .04 | .12 | |
| 13,000 | — .04 | .14 | |
| 14,000 | — .03 | .15 | |
| 15,000 | — .03 | .16 | |
| 16,000 | — .02 | .18 | |
| 17,000 | — .02 | .20 | |
| 18,000 | — .01 | .21 | |
| 19,000 | — .01 | .22 | |
| 20,000 | 0. | .24 | |
| 21,000 | 0. | .26 | |
| 22,000 | + .01 | .28 | |
| 23,000 | .02 | .31 | |
| 24,000 | .04 | .34 | |
| 25,000 | .06 | .38 | |
| 26,000 | .12 | .48 | |
| 27,000 | .23 | .65 | |
| 28,000 | .67 | 1.25 | Ultimate strength = 979 pounds per square inch. |

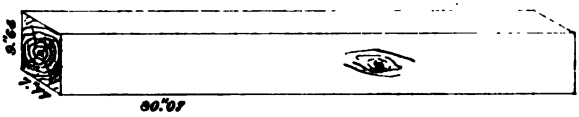
Failed by deflection sideways and upward, taking a contrary direction to the upward initial bend in the post but continuing the initial sideways bend.

The piece set in near end *A* did not appear to have caused weakness and given direction to final deflection, although it was on the concave side at final failure.

COMPRESSION OF WHITE-PINE POSTS—(Continued).

*Specimens from stock* 8″ × 10″, 6″ × 16″, 7″ × 16″, *and* 9″ × 17″.

No. 569.



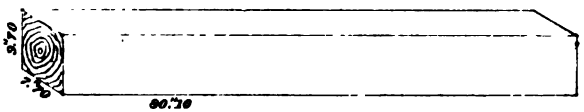
Sectional area, 74.9 square inches.
Gauged length, 50″.
Weight, 94 pounds.
Not counterweighted.
Average rate of growth, 10 rings per inch.

Digitized by Google

| Loads applied. | Pounds per square inch. | Compression. | Permanent set. | Remarks. |
|---|---|---|---|---|
| *Pounds.* | | *Inch.* | *Inch.* | |
| 7,490 | 100 | 0. | | |
| 37,450 | 500 | .0129 | | |
| | 100 | | 0. | |
| 74,900 | 1,000 | .0311 | | |
| | 100 | | — .0005 | |
| 112,350 | 1,500 | .0505 | | |
| | 100 | | | |
| 149,800 | 2,000 | .0704 | | |
| | 100 | | 0. | |
| 204,000 | 2,724 | | | Ultimate strength. |

Failed at knots 10″ from middle of post.

No. 570.

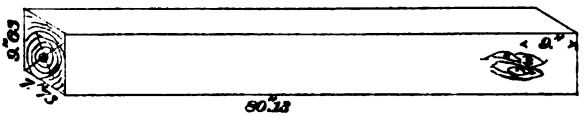


Sectional area, 74.7 square inches.
Gauged length, 50″.
Weight, 93 pounds.
Not counterweighted.
Average rate of growth, 7 rings per inch.

| Loads applied. | Pounds per square inch. | Compression. | Permanent set. | Remarks. |
|---|---|---|---|---|
| *Pounds.* | | *Inch.* | *Inch.* | |
| 7,470 | 100 | 0. | | |
| 37,350 | 500 | .0150 | | |
| | 100 | | — .0004 | |
| 74,700 | 1,000 | .0360 | | |
| | 100 | | — .0010 | |
| 112,050 | 1,500 | .0580 | | |
| | 100 | | — .0010 | |
| 149,400 | 2,000 | .0810 | | |
| | 100 | | .0004 | |
| 177,000 | 2,369 | | | Ultimate strength. |

Failed at some knots near middle of post.

No. 571.



Sectional area, 74.4 square inches.
Gauged length, 50″.
Weight, 120½ pounds.
Post contains considerable sap.
Not counterweighted.
Average rate of growth, 12 rings per inch.



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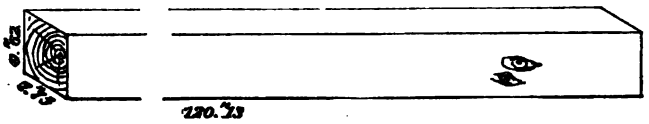
| Loads applied. | Pounds per square inch. | Compression. | Permanent set. | Remarks. |
|---|---|---|---|---|
| *Pounds.* | | *Inch.* | *Inch.* | |
| 7,440 | 100 | 0. | | |
| 37,200 | 500 | .0120 | | |
| | 100 | | 0. | |
| 74,400 | 1,000 | .0314 | | |
| | 100 | | 0. | |
| 111,600 | 1,500 | .0522 | | |
| | 100 | | —.0002 | |
| 148,800 | 2,000 | .0730 | | |
| | 100 | | 0. | |
| 185,000 | 2,487 | | | Ultimate strength. |

Failed at a group of knots 9″ from end of post.

No. 575.

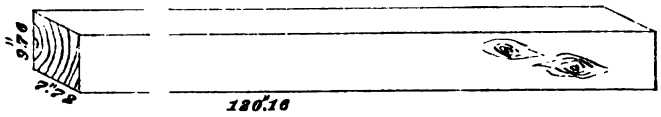


Sectional area, 74.6 square inches.
Gauged length, 100″.
Weight, 166 pounds.
Not counterweighted.
Average rate of growth, 15 rings per inch.

| Loads applied. | Pounds per square inch. | Compression. | Permanent set. | Remarks. |
|---|---|---|---|---|
| *Pounds.* | | *Inch.* | *Inch.* | |
| 7,460 | 100 | 0. | | |
| 37,300 | 500 | .0302 | | |
| | 100 | | 0. | |
| 74,600 | 1,000 | .0695 | | |
| | 100 | | 0. | |
| 111,900 | 1,500 | .1110 | | |
| | 100 | | 0. | |
| 149,200 | 2,000 | .1537 | | |
| | 100 | | .0010 | |
| 186,000 | 2,493 | | | Ultimate strength. |

Failed at some knots 21″ from end of post.

No. 576.



Sectional area, 75.3 square inches.
Gauged length, 100″.
Weight, 166 pounds.
Not counterweighted.
Average rate of growth, 11 rings per inch.

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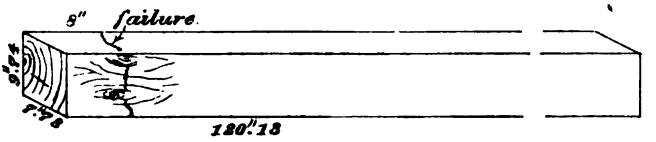
| Loads applied. | Pounds per square inch. | Compression. | Permanent set. | Remarks. |
|---|---|---|---|---|
| *Pounds.* | | *Inch.* | *Inch.* | |
| 7,530 | 100 | 0. | ..... | |
| 37,650 | 500 | .0276 | ..... | |
| ..... | 100 | ..... | 0. | |
| 75,300 | 1,000 | .0625 | ..... | |
| ..... | 100 | ..... | .0008 | |
| 112,950 | 1,500 | .0988 | ..... | |
| ..... | 100 | ..... | .0018 | |
| 150,600 | 2,000 | .1879 | ..... | |
| ..... | 100 | ..... | .0031 | |
| 204,600 | 2,717 | ..... | ..... | Ultimate strength. |

Failed in the vicinity of knots 13″ and 27″ from end of post.

No. 577.

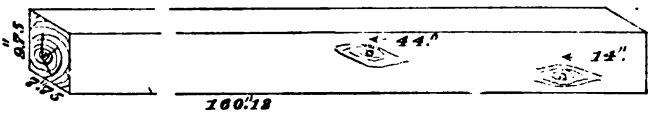



Sectional area, 75.3 square inches.
Gauged length, 100″.
Weight, 160 pounds.
Not counterweighted.
Average rate of growth, 10 rings per inch.

| Loads applied. | Pounds per square inch. | Compression. | Permanent set. | Remarks. |
|---|---|---|---|---|
| *Pounds.* | | *Inch.* | *Inch.* | |
| 7,530 | 100 | 0. | ..... | |
| 37,650 | 500 | .0268 | ..... | |
| ..... | 100 | ..... | 0. | |
| 75,300 | 1,000 | .0657 | ..... | |
| ..... | 100 | ..... | ..... | |
| 112,950 | 1,500 | .1070 | ..... | |
| ..... | 100 | ..... | .0005 | |
| 135,000 | 1,793 | ..... | ..... | Ultimate strength. |

Failed at knots 8″ to 11″ from end.

No. 581.



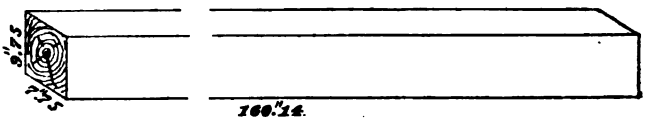

Sectional area, 75.6 square inches.
Gauged length, 100″.
Weight, 221 pounds.
Not counterweighted.
Average rate of growth, 7 rings per inch.

Digitized by Google

| Loads applied. | Pounds per square inch. | Compression. | Permanent set. | Remarks. |
|---|---|---|---|---|
| *Pounds.* | | *Inch.* | *Inch.* | |
| 7,560 | 100 | 0. | | |
| 37,800 | 500 | .0312 | | |
| | 100 | | —.0005 | |
| 75,600 | 1,000 | .0750 | | |
| | 100 | | —.0005 | |
| 113,400 | 1,500 | .1210 | | |
| | 100 | | —.0004 | |
| 151,200 | 2,000 | .1718 | | |
| | 100 | | .0014 | |
| 168,000 | 2,222 | | | Ultimate strength. |

Failed at knots 14″ and 44″ from end.

No. 582.

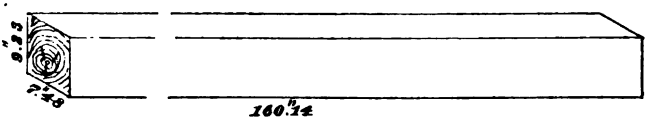



Sectional area, 75.6 square inches.
Gauged length, 100″.
Weight, 182 pounds.
Not counterweighted.
Average rate of growth, 3 rings per inch.

| Loads applied. | Pounds per square inch. | Compression. | Permanent set. | Remarks. |
|---|---|---|---|---|
| *Pounds.* | | *Inch.* | *Inch.* | |
| 7,560 | 100 | 0. | | |
| 37,800 | 500 | .0510 | | |
| | 100 | | .0010 | |
| 75,600 | 1,000 | .1167 | | |
| | 100 | | .0015 | |
| 113,400 | 1,500 | .1880 | | |
| | 100 | | .0046 | |
| 127,500 | 1,687 | | | Ultimate strength. |

Failed at knots 1¼″ diameter, 13″ and 18″ from end.

No. 583.




Sectional area, 69 square inches.
Gauged length, 100″.
Weight, 196½ pounds.
Not counterweighted.
Average rate of growth, 13 rings per inch.

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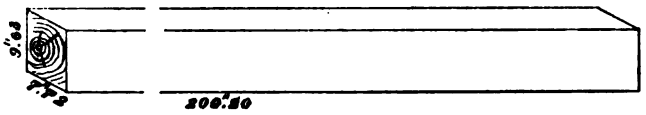
| Loads applied. | Pounds per square inch. | Compression. | Permanent set. | Remarks. |
|---|---|---|---|---|
| *Pounds.* | | *Inch.* | *Inch.* | |
| 6,900 | 100 | | | |
| 34,500 | 500 | .0298 | | |
| | 100 | | .0010 | |
| 69,000 | 1,000 | .0625 | | |
| | 100 | | .0010 | |
| 103,500 | 1,500 | .0950 | | |
| | 100 | | .0020 | |
| 208,500 | 3,022 | | | Ultimate strength. |

Failed at a group of knots 50″ from end; largest knot, 1⅛″ diameter.

No. 590.

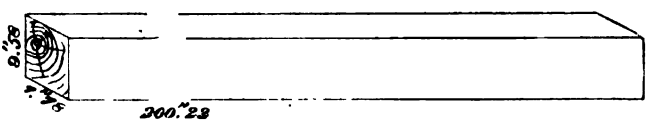



Sectional area, 74.3 square inches.
Gauged length, 150″.
Weight, 242 pounds.
Counterweight at middle, 126 pounds.
Average rate of growth, 7 rings per inch.

| Loads applied. | Pounds per square inch. | Compression. | Permanent set. | Deflections. | | Remarks. |
|---|---|---|---|---|---|---|
| | | | | Horizontal. | Vertical. | |
| *Pounds.* | | *Inch.* | *Inch.* | *Inch.* | *Inch.* | |
| 7,430 | 100 | 0. | | 0. | 0. | |
| 37,150 | 500 | .0446 | | .01 | .03 | |
| | 100 | | 0. | 0. | 0. | |
| 74,300 | 1,000 | .1060 | | .03 | .05 | |
| | 100 | | 0. | 0. | 0. | |
| 111,450 | 1,500 | .1710 | | .06 | .06 | |
| | 100 | | .0010 | .01 | .01 | |
| 148,600 | 2,000 | .2450 | | .10 | .05 | |
| | 100 | | .0040 | .01 | 0. | |
| 161,000 | 2,167 | | | .28 | —.05 | Ultimate strength. |

Failed at knots 20″ from end. Five knots at place of failure, size varying from 1″ to 1½″ diameter.

No. 591.




Sectional area, 74.5 square inches.
Gauged length, 150″.
Weight, 210½ pounds.
Counterweight at middle, 108 pounds.
Average rate of growth, 9 rings per inch.

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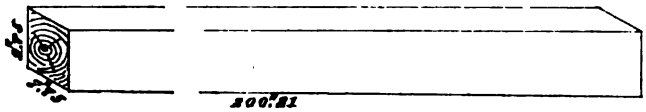
| Loads applied. | Pounds per square inch. | Compression. | Permanent set. | Deflections. | | Remarks. |
|---|---|---|---|---|---|---|
| | | | | Horizontal. | Vertical. | |
| *Pounds.* | | *Inch.* | *Inch.* | *Inch.* | *Inch.* | |
| 7,450 | 100 | 0. | ..... | 0. | 0. | |
| 37,250 | 500 | .0565 | ..... | 0. | — .01 | |
| ..... | 100 | ..... | .0015 | 0. | 0. | |
| 74,500 | 1,000 | .1275 | ..... | 0. | — .02 | |
| ..... | 100 | ..... | .0020 | 0. | 0. | |
| 111,750 | 1,500 | .2008 | ..... | — .01 | — .04 | |
| ..... | 100 | ..... | .0030 | 0. | — .0 | |
| 149,000 | 2,000 | .2850 | ..... | .06 | 0. | |
| ..... | 100 | ..... | .0094 | 0. | 0. | |
| 163,000 | 2,188 | ..... | ..... | .35 | — .30 | Ultimate strength. |

Failed at a group of knots near middle of post; one knot 2″ diameter.

No. 592.

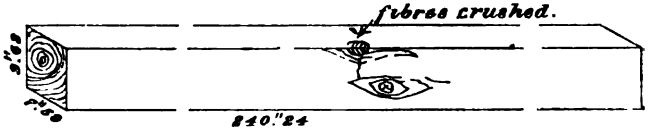



Sectional area, 75.6 square inches.
Gauged length, 150″.
Weight, 274 pounds.
Counter weight at middle, 138 pounds.
Average rate of growth, 8 rings per inch.

| Loads applied. | Pounds per square inch. | Compression. | Permanent set. | Deflections. | | Remarks. |
|---|---|---|---|---|---|---|
| | | | | Horizontal. | Vertical. | |
| *Pounds.* | | *Inch.* | *Inch.* | *Inch.* | *Inch.* | |
| 7,560 | 100 | 0. | ..... | 0. | 0. | This post contained 22 knots, averaging 2″ diameter. |
| 37,800 | 500 | .0510 | ..... | 0. | — .04 | |
| ..... | 100 | ..... | .0012 | 0. | 0. | |
| 75,600 | 1,000 | .1123 | ..... | 0. | — .07 | |
| ..... | 100 | ..... | .0023 | 0. | 0. | |
| 113,400 | 1,500 | .1760 | ..... | 0. | — .10 | |
| ..... | 100 | ..... | .0037 | 0. | 0. | |
| 151,200 | 2,000 | .2476 | ..... | .03 | — .14 | |
| ..... | 100 | ..... | .0088 | 0. | 0. | |
| 175,800 | 2,319 | ..... | ..... | .10 | — .21 | Ultimate strength. |

Failed 75″ from end, at a knot 2¼″ diameter.

No. 533.




Sectional area, 73 square inches.
Gauged length, 200″.
Weight, 278 pounds.
Counterweight at middle, 138 pounds.
Post contains 30 knots, from ½″ to 1½″ diameter.

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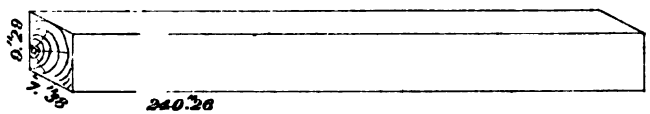
| Loads applied. | Pounds per square inch. | Compression. | Permanent set. | Deflections. Horizontal. | Deflections. Vertical. | Remarks. |
|---|---|---|---|---|---|---|
| *Pounds.* | | *Inch.* | *Inch.* | *Inch.* | *Inch.* | |
| 7,300 | 100 | 0. | | 0. | 0. | |
| 36,500 | 500 | .0693 | | −.02 | −.03 | |
| | 100 | | .0003 | 0. | 0. | |
| 73,000 | 1,000 | .1570 | | −.05 | −.06 | |
| | 100 | | .0010 | 0. | 0. | |
| 109,500 | 1,500 | .2470 | | −.08 | −.10 | |
| | 100 | | .0030 | 0. | −.01 | |
| 140,000 | 1,918 | | | −1.20 | −.49 | Ultimate strength. |

Deflected sideways. Fibers crushed at some knots at middle of post.

No. 534.

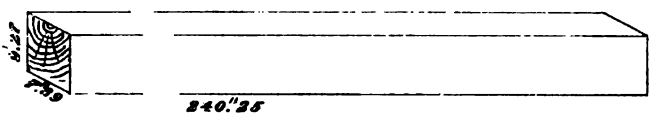



Sectional area, 68.6 square inches.
Gauged length, 200″.
Weight, 285 pounds.
Counterweight at middle, 138 pounds.
Quality of post as regards knots about the same as No. 533.

| Loads applied. | Pounds per square inch. | Compression. | Permanent set. | Deflections. Horizontal. | Deflections. Vertical. | Remarks. |
|---|---|---|---|---|---|---|
| *Pounds.* | | *Inch.* | *Inch.* | *Inch.* | *Inch.* | |
| 6,860 | 100 | 0. | | 0. | 0. | |
| 34,300 | 500 | .0580 | | .01 | .07 | |
| | 100 | | 0. | 0. | 0. | |
| 68,600 | 1,000 | .1336 | | 0. | .15 | |
| | 100 | | 0. | 0. | .01 | |
| 80,000 | | | | −.01 | .18 | |
| 90,000 | | | | −.02 | .20 | |
| 100,000 | | | | −.03 | .21 | |
| 110,000 | | | | −.05 | .24 | |
| 120,000 | | | | −.07 | .26 | |
| 130,000 | | | | −.10 | .29 | |
| 140,000 | | | | −.15 | .30 | |
| 150,000 | | | | −.21 | .32 | |
| 160,000 | | | | −.35 | .34 | |
| 166,000 | 2,420 | | | −.70 | .34 | Ultimate strength. |

Fibers crushed at knot near middle of post.

No. 535.




Sectional area, 68.5 square inches.
Gauged length, 200″.

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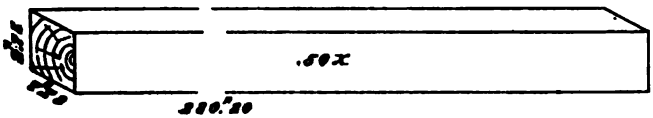
Weight, 295 pounds.
Counterweight at middle, 138 pounds.

| Loads applied. | Pounds per square inch. | Compression. | Permanent set. | Deflections. | | Remarks. |
|---|---|---|---|---|---|---|
| | | | | Horizontal. | Vertical. | |
| *Pounds.* | | *Inch.* | *Inch.* | *Inch.* | *Inch.* | |
| 6, 850 | 100 | 0. | ..... | 0. | 0. | |
| 34, 250 | 500 | .0468 | ..... | 0. | .02 | |
| ..... | 100 | ..... | 0. | 0. | 0. | |
| 68, 500 | 1, 000 | .1090 | ..... | 0. | .04 | |
| ..... | 100 | ..... | 0. | 0. | 0. | |
| 102, 750 | 1, 500 | .1738 | ..... | −.01 | .04 | |
| ..... | 100 | ..... | 0. | 0. | 0. | |
| 110, 000 | ..... | ..... | ..... | −.08 | .03 | |
| 120, 000 | ..... | ..... | ..... | −.04 | .04 | |
| 130, 000 | ..... | ..... | ..... | −.04 | .04 | |
| 140, 000 | ..... | ..... | ..... | −.05 | .04 | |
| 150, 000 | ..... | ..... | ..... | −.06 | .04 | |
| 160, 000 | ..... | ..... | ..... | −.08 | .04 | |
| 170, 000 | ..... | ..... | ..... | −.08 | .03 | |
| 180, 000 | ..... | ..... | ..... | −.09 | .03 | |
| 190, 000 | ..... | ..... | ..... | −.10 | .02 | |
| 200, 000 | ..... | ..... | ..... | −.10 | .01 | |
| 206, 000 | 3, 007 | ..... | ..... | +.10 | −.04 | Ultimate strength. |

**Failed at some knots 24″ from middle of post; maximum deflection at this point.**

No. 539.




Sectional area, 75.4 square inches.
Gauged length, 200″.
Weight, 352 pounds.
Counterweight at middle, 176 pounds.
Initial bend in post before dressing down from size 8″ × 10″: Horizontal −″.50.

| Loads applied. | Pounds per square inch. | Compression. | Permanent set. | Deflections. | | Remarks. |
|---|---|---|---|---|---|---|
| | | | | Horizontal. | Vertical. | |
| *Pounds.* | | *Inch.* | *Inch.* | *Inch.* | *Inch.* | |
| 7, 540 | 100 | 0. | ..... | 0. | 0. | |
| 37, 700 | 500 | .0760 | ..... | −.04 | .03 | |
| ..... | 100 | ..... | .0006 | 0. | 0. | |
| 75, 400 | 1, 000 | .1710 | ..... | −.08 | .10 | |
| ..... | 100 | ..... | .0010 | 0. | 0. | |
| 113, 100 | 1, 500 | .2700 | ..... | −.21 | .15 | |
| ..... | 100 | ..... | .0025 | 0. | 0. | |
| 120, 000 | ..... | ..... | ..... | −.26 | .19 | |
| 130, 000 | ..... | ..... | ..... | −.38 | .20 | |
| 140, 000 | 1, 857 | ..... | ..... | −.66 | .22 | Ultimate strength. |

Sustained maximum load 3 minutes, horizontal deflection increasing rapidly.

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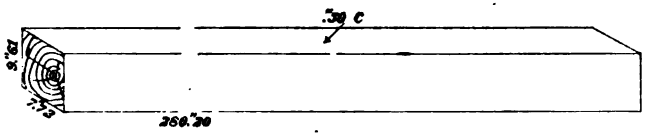
No. 540.

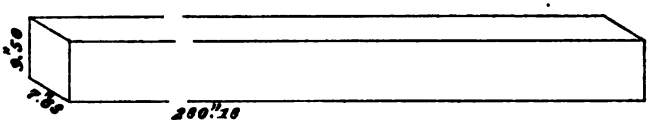


Sectional area, 74.2 square inches.
Gauged length, 200″.
Weight, 357 pounds.
Counterweight at middle, 178 pounds.
Initial deflection before dressing down from size 8″×10″: Vertical —″50.

| Loads applied. | Pounds per square inch. | Compression. | Permanent set. | Deflections. Horizontal. | Deflections. Vertical. | Remarks. |
|---|---|---|---|---|---|---|
| *Pounds.* | | *Inch.* | *Inch.* | *Inch.* | *Inch.* | |
| 7,420 | 100 | 0. | ..... | 0. | 0. | Post contains 32 knots, varying in diameter from ½″ to 1½″. |
| 37,100 | 500 | .0556 | ..... | .03 | — .02 | |
| ..... | 100 | ..... | .0010 | 0. | 0. | |
| 74,200 | 1,000 | .1240 | ..... | .09 | — .08 | |
| ..... | 100 | ..... | .0015 | 0. | 0. | |
| 111,300 | 1,500 | .1960 | ..... | .17 | — .03 | |
| ..... | 100 | ..... | .0020 | 0. | 0. | |
| 120,000 | ..... | ..... | ..... | .17 | — .03 | |
| 130,000 | ..... | ..... | ..... | .20 | — .03 | |
| 140,000 | ..... | ..... | ..... | .25 | — .04 | |
| 150,000 | ..... | ..... | ..... | .33 | — .03 | |
| 160,000 | ..... | ..... | ..... | .44 | — .02 | |
| 170,000 | 2,291 | ..... | ..... | .86 | + .04 | Ultimate strength. |

Failed by horizontal deflection, fibers crushing at knots near the middle.

No. 541.



Sectional area, 72.5 square inches.
Gauged length, 200″.
Weight, 340 pounds.
Counterweight at middle, 170 pounds.

| Loads applied. | Pounds per square inch. | Compression. | Permanent set. | Deflections. Horizontal. | Deflections. Vertical. | Remarks. |
|---|---|---|---|---|---|---|
| *Pounds.* | | *Inch.* | *Inch.* | *Inch.* | *Inch.* | |
| 7,250 | 100 | 0. | ..... | 0. | 0. | |
| 36,250 | 500 | .0580 | ..... | 0. | 0. | |
| ..... | 100 | ..... | .0014 | 0. | 0. | |
| 72,500 | 1,000 | .1360 | ..... | — .10 | 0. | |
| ..... | 100 | ..... | .0020 | 0. | 0. | |
| 108,750 | 1,500 | .2140 | ..... | — .25 | .04 | |
| ..... | 100 | ..... | .0030 | — .02 | 0. | |
| 120,000 | ..... | ..... | ..... | — .32 | .05 | |
| 130,000 | ..... | ..... | ..... | — .41 | .10 | |
| 140,000 | ..... | ..... | ..... | — .61 | .15 | |
| 150,000 | 2,069 | ..... | ..... | —1.22 | .40 | Ultimate strength. |

Failed by deflecting diagonally sideways and upward.

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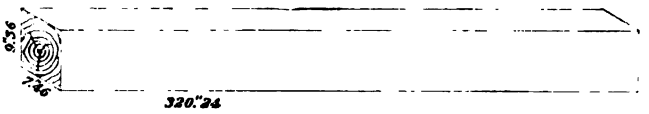
No. 536.

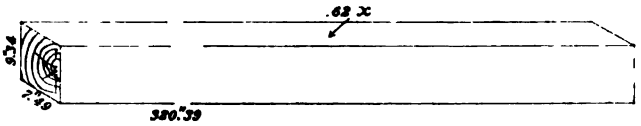



Sectional area, 69.8 square inches.
Gauged length, 300″.
Weight, 427 pounds.
Counterweight at middle, 214 pounds.

| Loads applied. | Pounds per square inch. | Compression. | Permanent set. | Deflections. Horizontal. | Deflections. Vertical. | Remarks. |
|---|---|---|---|---|---|---|
| *Pounds.* | | *Inch.* | *Inch.* | *Inch.* | *Inch.* | |
| 6,980 | 100 | 0. | ..... | 0. | 0. | |
| 34,900 | 500 | .0745 | ..... | 0. | .03 | |
| ..... | 100 | ..... | 0. | 0. | 0. | |
| 69,800 | 1,000 | .1992 | ..... | 0. | .08 | |
| ..... | 100 | ..... | .0005 | 0. | 0. | |
| 104,700 | 1,500 | .2705 | ..... | .03 | .11 | |
| ..... | 100 | ..... | .0017 | 0. | 0. | |
| 110,000 | ..... | ..... | ..... | .01 | .13 | |
| 120,000 | ..... | ..... | ..... | .01 | .15 | |
| 130,000 | ..... | ..... | ..... | .03 | .16 | |
| 140,000 | ..... | ..... | ..... | .06 | .19 | |
| 150,000 | ..... | ..... | ..... | .10 | .21 | |
| 160,000 | ..... | ..... | ..... | .20 | .28 | |
| 169,000 | 2,421 | ..... | ..... | 1.00 | .15 | Ultimate strength. |

Failed by deflection sideways, crushing fibers at two places near middle of post at knots.

No. 537.




Sectional area, 70 square inches.
Gauged length, 300″.
Weight, 397 pounds.
Counterweight at middle, 200 pounds.
Initial bend in post before dressing down from size 8″×10″: Vertical, +″.62.

| Loads applied. | Pounds per square inch. | Compression. | Permanent set. | Deflections. Horizontal. | Deflections. Vertical. | Remarks. |
|---|---|---|---|---|---|---|
| *Pounds.* | | *Inch.* | *Inch.* | *Inch.* | *Inch.* | |
| 7,000 | 100 | 0. | ..... | 0. | 0. | |
| 35,000 | 500 | .0930 | ..... | — .02 | — .07 | |
| ..... | 100 | ..... | .0024 | 0. | 0. | |
| 70,000 | 1,000 | .2025 | ..... | — .10 | — .09 | |
| ..... | 100 | ..... | .0030 | — .01 | 0. | |
| 105,000 | 1,500 | .3144 | ..... | — .22 | — .10 | |
| ..... | 100 | ..... | .0044 | — .02 | 0. | |
| 110,000 | ..... | ..... | ..... | — .27 | — .10 | |
| 120,000 | ..... | ..... | ..... | — .34 | — .10 | |
| 130,000 | ..... | ..... | ..... | — .46 | — .10 | |
| 140,000 | 2,000 | ..... | ..... | — .70 | — .10 | Ultimate strength. |

Deflected sideways, taking a sharp bend at middle at some knots.

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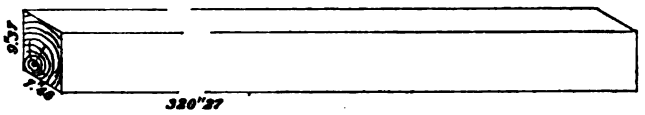
No. 538.

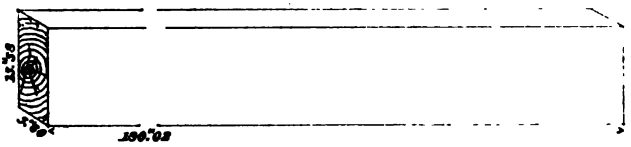


Sectional area, 69.9 square inches.
Gauged length, 300″.
Weight, 384 pounds.
Counterweight at middle, 200 pounds.

| Loads applied. | Pounds per square inch. | Compression. | Permanent set. | Deflections. Horizontal. | Deflections. Vertical. | Remarks. |
|---|---|---|---|---|---|---|
| *Pounds.* | | *Inch.* | *Inch.* | *Inch.* | *Inch.* | |
| 6,990 | 100 | 0. | ..... | 0. | 0. | |
| 34,950 | 500 | .0942 | ..... | 0. | — .04 | |
| ..... | 100 | ..... | .0017 | 0. | 0. | |
| 69,900 | 1,000 | .2150 | ..... | .03 | — .12 | |
| ..... | 100 | ..... | —.0042 | 0. | 0. | |
| 104,850 | 1,500 | .3444 | ..... | .15 | — .22 | |
| ..... | 100 | ..... | .0095 | 0. | — .01 | |
| 110,000 | ..... | ..... | ..... | .18 | — .25 | |
| 120,000 | ..... | ..... | ..... | .30 | — .30 | |
| 130,000 | ..... | ..... | ..... | .72 | — .42 | |
| 134,000 | 1,917 | ..... | ..... | 1.67 | — .60 | Ultimate strength. |

Deflected sideways and downward, crushing the fibers on concave side at knots.

No. 702.



Sectional area, 87.2 square inches.
Gauged length, 150″.
Weight, 300 pounds.
Average weight of growth, 10 rings per inch.

| Loads applied. | Pounds per square inch. | Compression. | Permanent set. | Deflections. Horizontal. | Deflections. Vertical, W. | Deflections. Vertical, E. | Remarks. |
|---|---|---|---|---|---|---|---|
| *Pounds.* | | *Inch.* | *Inch.* | *Inch.* | *Inch.* | | |
| 0 | 0 | 0. | | 0. | 0. | 0. | |
| 43,600 | 500 | .0700 | 0. | .01 | — .03 | ..... | |
| ..... | 0 | ..... | ..... | ..... | ..... | ..... | |
| 60,000 | ..... | ..... | .0005 | .01 | — .03 | ..... | |
| 80,000 | ..... | ..... | ..... | 0. | — .04 | ..... | |
| 100,000 | ..... | ..... | ..... | 0. | — .04 | .01 | |
| 120,000 | ..... | ..... | ..... | — .02 | — .04 | ..... | |
| 140,000 | ..... | ..... | ..... | — .10 | — .05 | ..... | |
| 150,000 | ..... | ..... | ..... | — .20 | — .06 | .10 | |
| 159,000 | 1,823 | ..... | ..... | — .37 | — .10 | ..... | Ultimate strength. |

NOTE.—The letters W and E are used to indicate that vertical deflections were taken on the west and east side of machine. The measurements show an apparent vertical movement, plus on one side and minus on the other, as the stick twisted during the test.

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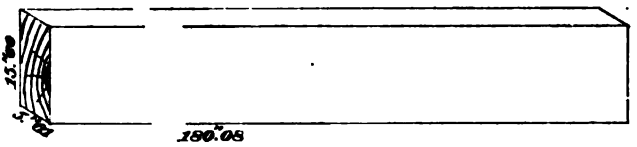
Fibers crushed 23″ from end at a group of knots.

No. 703.

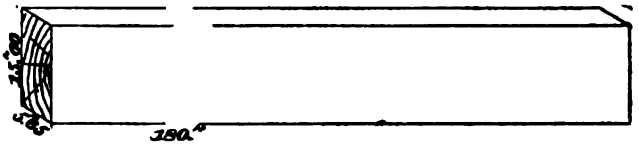


Sectional area, 87.5 square inches.
Gauged length, 150″.
Weight, 267 pounds.
Average rate of growth, 5 rings per inch.

| Loads applied. | Pounds per square inch. | Compression. | Permanent set. | Deflections. | | | Remarks. |
|---|---|---|---|---|---|---|---|
| | | | | Horizontal. | Vertical, W. | Vertical, E. | |
| *Pounds.* | | *Inch.* | *Inch.* | *Inch.* | *Inch.* | *Inch.* | |
| 0 | 0 | 0. | ..... | 0. | 0. | 0. | |
| 43, 750 | 500 | .0760 | ..... | .07 | .06 | — .05 | |
| ..... | 0 | ..... | .0007 | ..... | ..... | ..... | |
| 60, 000 | ..... | ..... | ..... | .04 | .07 | ..... | |
| 80, 000 | ..... | ..... | ..... | .02 | .09 | ..... | |
| 100, 000 | ..... | ..... | ..... | 0. | .10 | 0. | |
| 120, 000 | ..... | ..... | ..... | — .03 | .10 | ..... | |
| 140, 000 | ..... | ..... | ..... | — .08 | .10 | ..... | |
| 155, 000 | ..... | ..... | ..... | — .15 | .10 | ..... | |
| 160, 000 | ..... | ..... | ..... | — .20 | .10 | ..... | |
| 168, 500 | 1, 926 | ..... | ..... | — .51 | .12 | ..... | Ultimate strength. |

Failed by horizontal deflection, minus direction; took maximum deflection at a group of knots about 12″ from middle of stick.

No. 704.



Sectional area, 88.1 square inches.
Gauged length, 150″.
Weight, 267 pounds.
Average rate of growth, 12 rings per inch.

| Loads applied. | Pounds per square inch. | Compression. | Permanent set. | Deflections. | | | Remarks. |
|---|---|---|---|---|---|---|---|
| | | | | Horizontal. | Vertical, W. | Vertical, E. | |
| *Pounds.* | | *Inch.* | *Inch.* | *Inch.* | *Inch.* | *Inch.* | |
| 0 | 0 | 0. | ..... | 0. | 0. | 0. | |
| 44, 050 | 500 | .0653 | ..... | 0. | 0. | 0. | |
| ..... | 0 | ..... | .0003 | ..... | ..... | ..... | |
| 60, 000 | ..... | ..... | ..... | — .01 | 0. | ..... | |
| 80, 000 | ..... | ..... | ..... | — .07 | — .01 | ..... | |
| 100, 000 | ..... | ..... | ..... | — .11 | — .02 | ..... | |
| 120, 000 | ..... | ..... | ..... | — .20 | — .03 | ..... | |
| 140, 000 | ..... | ..... | ..... | — .31 | — .03 | ..... | |
| 150, 000 | ..... | ..... | ..... | — .40 | — .05 | 0. | |
| 160, 000 | ..... | ..... | ..... | — .55 | — .06 | ..... | |
| 165, 000 | 1, 873 | ..... | ..... | — .83 | — .10 | ..... | Ultimate strength. |

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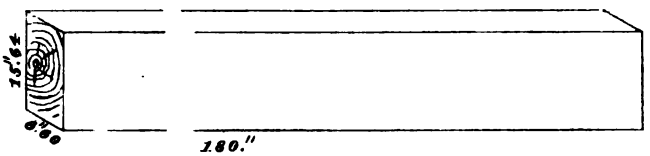
Failed by horizontal deflection, minus direction; fibers crushed about 12″ from south end at a group of knots.

No. 699.

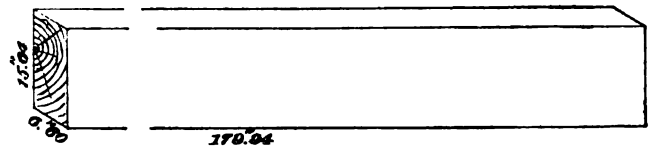



Sectional area, 103.2 square inches.
Weight, 356 pounds.
Gauged length, 150″.
Average rate of growth, 7 rings per inch.

| Loads applied. | Pounds per square inch. | Compression. | Permanent set. | Deflections. | | | Remarks. |
|---|---|---|---|---|---|---|---|
| | | | | Horizontal. | Vertical, W. | Vertical, E. | |
| *Pounds.* | | *Inch.* | *Inch.* | *Inch.* | *Inch.* | *Inch.* | |
| 0 | 0 | 0. | 0. | 0. | 0. | 0. | |
| 51,600 | 500 | .0435 | ..... | 0. | .05 | .02 | |
| 0 | 0 | ..... | 0. | ..... | ..... | ..... | |
| 80,000 | ..... | ..... | ..... | .01 | .06 | ..... | |
| 100,000 | ..... | ..... | ..... | .01 | .07 | .02 | |
| 120,000 | ..... | ..... | ..... | .02 | .08 | ..... | |
| 140,000 | ..... | ..... | ..... | .02 | .09 | ..... | |
| 160,000 | ..... | ..... | ..... | .02 | .10 | ..... | |
| 180,000 | ..... | ..... | ..... | .02 | .10 | ..... | |
| 200,000 | ..... | ..... | ..... | .02 | .10 | 0. | |
| 220,000 | ..... | ..... | ..... | .02 | .11 | ..... | |
| 230,000 | ..... | ..... | ..... | .02 | .11 | ..... | |
| 240,000 | 2,326 | ..... | ..... | .03 | .11 | ..... | Ultimate strength. |

Failed by crushing fibres at a group of knots 40″ from end.

No. 700.




Sectional area, 103.2 square inches.
Gauged length, 150″.
Weight, 395 pounds.
Average rate of growth, 10 rings per inch.

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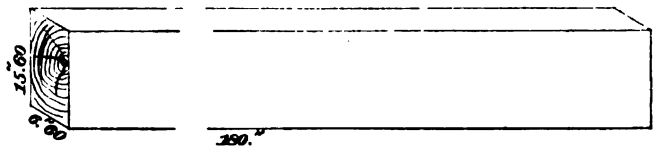
| Loads applied. | Pounds per square inch. | Compression. | Permanent set. | Deflections. | | | Remarks. |
|---|---|---|---|---|---|---|---|
| | | | | Horizontal. | Vertical, W. | Vertical, E. | |
| *Pounds.* | | *Inch.* | *Inch.* | *Inch.* | *Inch.* | *Inch.* | |
| 0 | 0 | 0. | ..... | 0. | 0. | 0. | |
| 51,600 | 500 | .0475 | ..... | .05 | .06 | 0. | |
| | 0 | .0 | .0 | | | | |
| 80,000 | ..... | ..... | ..... | .08 | .07 | ..... | |
| 100,000 | ..... | ..... | ..... | .09 | .08 | — .02 | |
| 120,000 | ..... | ..... | ..... | .11 | .09 | ..... | |
| 140,000 | ..... | ..... | ..... | .12 | .10 | ..... | |
| 160,000 | ..... | ..... | ..... | .15 | .12 | ..... | |
| 180,000 | ..... | ..... | ..... | .18 | .13 | ..... | |
| 200,000 | ..... | ..... | ..... | .21 | .16 | — .15 | |
| 220,000 | ..... | ..... | ..... | .26 | .20 | ..... | |
| 230,000 | ..... | ..... | ..... | .31 | .21 | — .20 | |
| 239,009 | 2,316 | ..... | ..... | .40 | .28 | ..... | Ultimate strength. |

Stick failed at knots 10″ and 60″ from north end; opened oblique longitudinal crack between the above groups of knots.

No. 701.

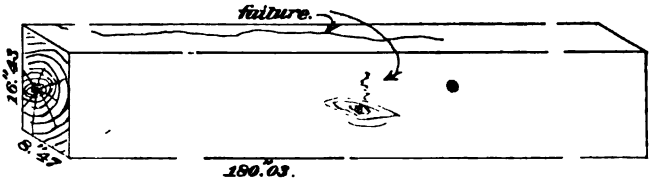



Sectional area, 103 square inches.
Gauged length, 150″.
Weight, 376 pounds.
Average rate of growth, 7 rings per inch.

| Loads applied. | Pounds per square inch. | Compression. | Permanent set. | Deflections. | | | Remarks. |
|---|---|---|---|---|---|---|---|
| | | | | Horizontal. | Vertical, W. | Vertical, E. | |
| *Pounds.* | | *Inch.* | *Inch.* | *Inch.* | *Inch.* | *Inch.* | |
| 0 | 0 | 0. | ..... | 0. | 0. | 0. | |
| 51,500 | 500 | .0519 | ..... | .03 | .04 | .02 | |
| | 0 | ..... | .0 | ..... | ..... | ..... | |
| 80,000 | ..... | ..... | ..... | .03 | .05 | ..... | |
| 100,000 | ..... | ..... | ..... | .03 | .05 | ..... | |
| 120,000 | ..... | ..... | ..... | .02 | .05 | ..... | |
| 140,000 | ..... | ..... | ..... | .02 | .06 | ..... | |
| 160,000 | ..... | ..... | ..... | .02 | .06 | ..... | |
| 180,000 | ..... | ..... | ..... | .02 | .06 | ..... | |
| 200,000 | ..... | ..... | ..... | .05 | .05 | ..... | |
| 203,000 | 1,971 | ..... | ..... | ..... | ..... | ..... | Ultimate strength. |

Failed at a group of knots 15″ from middle of post.

No. 705.




Sectional area, 139.2 square inches.
Gauged length, 150″.

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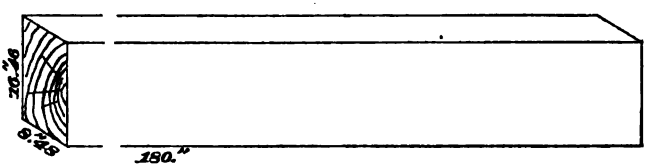
Weight, 657 pounds.
Average rate of growth, 6 rings per inch.
Stick in wet condition.

| Loads applied. | Pounds per square inch. | Compression. | Permanent set. | Deflections. | | | Remarks. |
|---|---|---|---|---|---|---|---|
| | | | | Horizontal. | Vertical, W. | Vertical, E. | |
| *Pounds.* | | *Inch.* | *Inch.* | *Inch.* | *Inch.* | *Inch.* | |
| 0 | 0 | 0. | ..... | 0. | 0. | 0. | |
| 69, 600 | 500 | .0508 | ..... | −.10 | .02 | ..... | |
| 0 | 0 | ..... | .0005 | ..... | ..... | ..... | |
| 80, 000 | ..... | ..... | ..... | −.10 | .03 | ..... | |
| 100, 000 | ..... | ..... | ..... | −.10 | .03 | .02 | |
| 140, 000 | ..... | ..... | ..... | −.10 | .05 | ..... | |
| 180, 000 | ..... | ..... | ..... | −.10 | .06 | ..... | |
| 200, 000 | ..... | ..... | ..... | −.11 | .05 | ..... | |
| 220, 000 | ..... | ..... | ..... | −.13 | .05 | ..... | |
| 230, 000 | ..... | ..... | ..... | −.15 | .04 | ..... | |
| 240, 000 | ..... | ..... | ..... | −.16 | .03 | ..... | |
| 250, 000 | ..... | ..... | ..... | −.19 | .02 | ..... | |
| 260, 000 | ..... | ..... | ..... | −.20 | .02 | ..... | |
| 270, 000 | ..... | ..... | ..... | −.25 | −.02 | .10 | |
| 279, 400 | 2, 007 | ..... | ..... | −.35 | −.09 | ..... | Ultimate strength. |

Failed by crushing fibers in vicinity of knot at middle of stick; also, opened oblique longitudinal crack.

No. 706.




Sectional area, 139.6 square inches.
Gauged length, 150″.
Weight, 437 pounds.
Average rate of growth, 5 rings per inch.

| Loads applied. | Pounds per square inch. | Compression. | Permanent set. | Deflections. | | | Remarks. |
|---|---|---|---|---|---|---|---|
| | | | | Horizontal. | Vertical, W. | Vertical, E. | |
| *Pounds.* | | *Inch.* | *Inch.* | *Inch.* | *Inch.* | *Inch.* | |
| 0 | 0 | 0. | ..... | 0. | 0. | 0. | |
| 69, 800 | 500 | .0590 | ..... | .02 | .08 | −.05 | |
| 0 | 0 | ..... | 0. | ..... | ..... | ..... | |
| 100, 000 | ..... | ..... | ..... | .03 | .10 | ..... | |
| 140, 000 | ..... | ..... | ..... | .03 | .13 | ..... | |
| 180, 000 | ..... | ..... | ..... | .03 | .19 | ..... | |
| 200, 000 | ..... | ..... | ..... | .03 | .20 | −.10 | |
| 220, 000 | ..... | ..... | ..... | .03 | .22 | ..... | |
| 240, 000 | ..... | ..... | ..... | .03 | .25 | ..... | |
| 260, 000 | ..... | ..... | ..... | .03 | .30 | −.15 | |
| 280, 000 | ..... | ..... | ..... | 0. | .37 | ..... | |
| 292, 000 | 2, 092 | ..... | ..... | −.10 | .45 | ..... | Ultimate strength. |

Failed at a group of knots at middle of stick, and at knots 29″ from north end.

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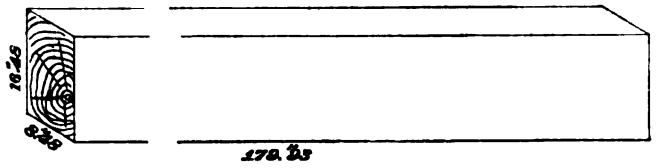
No. 707.



Sectional area, 139.8 inches.
Gauged length, 150″.
Weight, 447 pounds.
Average rate of growth, 5 rings per inch.

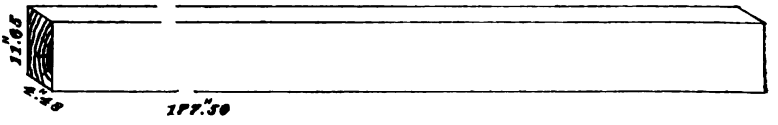
| Loads applied. | Pounds per square inch. | Compression. | Permanent set. | Deflections. Horizontal. | Deflections. Vertical, W. | Deflections. Vertical, E. | Remarks. |
|---|---|---|---|---|---|---|---|
| *Pounds.* | | *Inch.* | *Inch.* | *Inch.* | *Inch.* | *Inch.* | |
| 0 | 0 | | 0. | 0. | 0. | 0. | |
| 69, 900 | 500 | .0305 | | — .06 | .10 | .05 | |
| | 0 | | —.0005 | | | | |
| 100, 000 | | | | — .07 | .11 | | |
| 140, 000 | | | | — .08 | .13 | | |
| 180, 000 | | | | — .09 | .16 | | |
| 200. 000 | | | | — .10 | .18 | .05 | |
| 220, 000 | | | | — .10 | .19 | | |
| 240, 000 | | | | — .10 | .20 | | |
| 260, 000 | | | | — .10 | .21 | | |
| 280, 000 | | | | — .12 | .25 | | |
| 290, 000 | | | | — .13 | .26 | | |
| 300, 000 | | | | — .13 | .27 | | |
| 320, 000 | | | | — .15 | .30 | | |
| 340, 000 | | | | — .18 | .32 | | |
| 350, 000 | | | | — .22 | .40 | — .15 | |
| 359, 000 | 2, 568 | | | | | | Ultimate strength. |

Failed by horizontal deflection, minus direction. Fibers crushed at north end, where the wood was imperfect, giving direction to the final deflection.

## COMPRESSION TESTS OF WHITE PINE—(Continued.)

*Single sticks and built posts.*

No. 664.



Sectional area, 52.2 square inches.
Gauged length, 150″.
Weight, 153 pounds.
Average rate of growth, 11 rings per inch.

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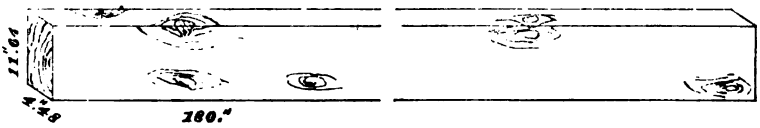
| Loads applied. | Pounds per square inch. | Compression. | Compression set. | Deflections. Horizontal. | Deflections. Vertical, W. | Deflections. Vertical, E. | Remarks. |
|---|---|---|---|---|---|---|---|
| *Pounds.* | | *Inch.* | *Inch.* | *Inch.* | *Inch.* | *Inch.* | |
| 0 | 0 | 0. | 0. | — .23 | 0. | 0. | |
| 26,100 | 500 | .0545 | ..... | 0. | .02 | ..... | |
| 0 | 0 | ..... | .0004 | — .21 | 0. | ..... | |
| 40,000 | ..... | ..... | ..... | + .02 | .04 | — .06 | |
| 60,000 | ..... | ..... | ..... | 0. | .07 | ..... | |
| 80,000 | ..... | ..... | ..... | — .06 | .07 | ..... | |
| 100,000 | ..... | ..... | ..... | — .20 | .07 | — .08 | |
| 110,000 | 2,107 | ..... | ..... | — .43 | .10 | ..... | Ultimate strength. |

Failed by horizontal deflection in minus direction.

Deflection increased to —2″.30 fibers of stick, crushing 15″ from middle, 2″ from north end, and 8″ from south end, in the vicinity of knots.

No. 665.




Sectional area, 52.1 square inches.

Weight, 143 pounds.

Gauged length, 150″.

Average rate of growth, 10 rings per inch.

| Loads applied. | Pounds per square inch. | Compression. | Compression set. | Deflections. Horizontal. | Deflections. Vertical, W. | Deflections. Vertical, E. | Remarks. |
|---|---|---|---|---|---|---|---|
| *Pounds.* | | *Inch.* | *Inch.* | *Inch.* | *Inch.* | *Inch.* | |
| 0 | 0 | 0. | 0. | — .07 | 0. | 0. | |
| 26,050 | 500 | .1010 | ..... | + .02 | ..... | ..... | |
| 0 | 0 | ..... | .0010 | — .07 | ..... | ..... | |
| 30,000 | ..... | ..... | ..... | + .02 | — .09 | — .06 | |
| 40,000 | ..... | ..... | ..... | + .02 | — .09 | ..... | |
| 50,000 | ..... | ..... | ..... | .04 | — .09 | ..... | |
| 60,000 | ..... | ..... | ..... | .10 | — .09 | ..... | |
| 70,000 | ..... | ..... | ..... | .15 | — .08 | ..... | |
| 80,000 | ..... | ..... | ..... | .40 | — .06 | ..... | |
| 81,500 | 1,564 | ..... | ..... | 1.15 | ..... | ..... | Ultimate strength. |

Failed by horizontal deflection, plus direction.

Sprung sideways suddenly after passing the maximum load. Rotating around vertical edges of ends similar to a post with pin ends. Fibers not crushed.



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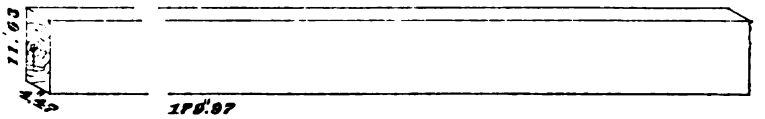
No. 666.

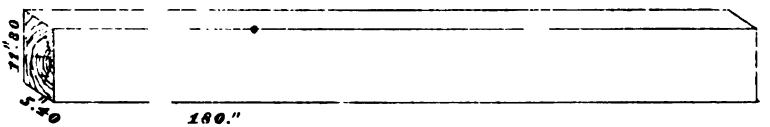



Sectional area, 52 square inches.
Gauged length, 150″.
Weight, 163 pounds.
Average rate of growth, 5 rings per inch.

| Loads applied. | Pounds per square inch. | Compression. | Compression set. | Deflections. Horizontal. | Vertical, W. | Vertical, E. | Remarks. |
|---|---|---|---|---|---|---|---|
| *Pounds.* | | *Inch.* | *Inch.* | *Inch.* | *Inch.* | *Inch.* | |
| 0 | 0 | 0. | ..... | 0. | 0. | 0. | |
| 26,000 | 500 | .0895 | ..... | .07 | — .10 | 0. | |
| 0 | 0 | ..... | .0004 | ..... | ..... | ..... | |
| 30,000 | ..... | ..... | ..... | .09 | — .10 | ..... | |
| 40,000 | ..... | ..... | ..... | .11 | — .12 | ..... | |
| 50,000 | ..... | ..... | ..... | .16 | — .13 | ..... | |
| 60,000 | ..... | ..... | ..... | .28 | — .13 | ..... | |
| 70,000 | 1,346 | ..... | ..... | 1.25 | ..... | ..... | Ultimate strength. |

Failed by horizontal deflection, plus direction.
When the horizontal deflection reached 3″ the post sprung suddenly sideways, rotating around vertical edges of ends.

No. 667.




Sectional area, 61 square inches.
Gauged length, 150″.
Weight, 228 pounds.
Average rate of growth, 13 rings per inch.

| Loads applied. | Pounds per square inch. | Compression. | Compression set. | Deflections. Horizontal. | Vertical, W. | Vertical, E. | Remarks. |
|---|---|---|---|---|---|---|---|
| *Pounds.* | | *Inch.* | *Inch.* | *Inch.* | *Inch.* | *Inch.* | |
| 0 | 0 | 0. | ..... | ..... | ..... | ..... | |
| 30,500 | 500 | .0505 | ..... | — .03 | .04 | — .04 | |
| 0 | 0 | ..... | 0. | ..... | ..... | ..... | |
| 50,000 | ..... | ..... | ..... | — .05 | .08 | ..... | |
| 60,000 | ..... | ..... | ..... | — .07 | .09 | ..... | |
| 70,000 | ..... | ..... | ..... | — .08 | .10 | — .10 | |
| 80,000 | ..... | ..... | ..... | — .09 | .10 | ..... | |
| 90,000 | ..... | ..... | ..... | — .10 | + .11 | ..... | |
| 100,000 | ..... | ..... | ..... | — .13 | .12 | — .15 | |
| 110,000 | ..... | ..... | ..... | — .15 | .15 | ..... | |
| 120,000 | ..... | ..... | ..... | — .19 | .16 | ..... | |
| 130,000 | ..... | ..... | ..... | — .22 | .17 | ..... | |
| 140,000 | ..... | ..... | ..... | — .30 | .18 | ..... | |
| 150,000 | ..... | ..... | ..... | — .87 | .20 | — .22 | |
| 160,000 | 2,623 | ..... | ..... | — .60 | .20 | ..... | Ultimate strength. |

Failed by horizontal deflection, minus direction.
Loads continued gradually increasing the deflection to 3″, fibers of the stick crushing at the middle and 3½″ to 4½″ from ends.

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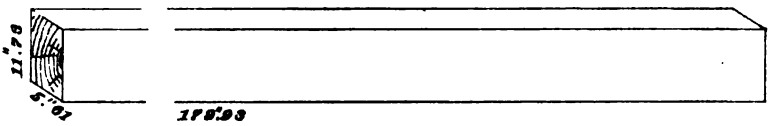
## No. 668.

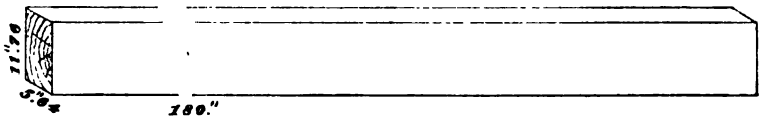


Sectional area, 65.8 square inches.
Gauged length, 150″.
Weight, 193 pounds.
Average rate of growth, 5 rings per inch.

| Loads applied. | Pounds per square inch. | Compression. | Compression set. | Deflections. Horizontal. | Vertical, W. | Vertical, E. | Remarks. |
|---|---|---|---|---|---|---|---|
| *Pounds.* | | *Inch.* | *Inch.* | *Inch.* | *Inch.* | *Inch.* | |
| 0 | 0 | 0. | | 0. | 0. | 0. | |
| 32, 900 | 500 | .0622 | | — .05 | — .03 | | |
| | 0 | | .0004 | | | | |
| 50, 000 | | | | — .08 | — .04 | | |
| 70, 000 | | | | — .10 | — .05 | | |
| 90, 000 | | | | — .14 | — .05 | | |
| 100, 000 | | | | — .16 | — .06 | .09 | |
| 110, 000 | | | | — .19 | — .07 | | |
| 120, 000 | | | | — .21 | — .07 | | |
| 130, 000 | | | | — .26 | — .09 | | |
| 140, 000 | | | | — .32 | — .10 | | |
| 150, 000 | | | | — .40 | — .10 | .18 | |
| 156, 300 | 2, 375 | | | — .60 | — .15 | | Ultimate strength. |

Failed by horizontal deflection, minus direction.
Deflections increased to 3″. Fibers crushed at a group of knots 30″ from middle, where maximum deflection occurred. Fibers also crushed at some knots 3″ to 6″ from north end.

## No. 669.



Sectional area, 66.3 square inches.
Gauged length, 150″.
Weight, 253 pounds.
Average rate of growth, 5 rings per inch.

| Loads applied. | Pounds per square inch. | Compression. | Compression set. | Deflections. Horizontal. | Vertical, W. | Vertical, E. | Remarks. |
|---|---|---|---|---|---|---|---|
| *Pounds.* | | *Inch.* | *Inch.* | *Inch.* | *Inch.* | *Inch.* | |
| 0 | 0 | 0 | | 0. | 0. | 0. | |
| 33, 150 | 500 | .0608 | | 0. | — .01 | | |
| | 0 | | 0004 | | | | |
| 50, 000 | | | | | — .02 | .02 | |
| 70, 000 | | | | .01 | — .05 | | |
| 90, 000 | | | | .04 | — .07 | .03 | |
| 100, 000 | | | | .05 | — .08 | | |
| 110, 000 | | | | .07 | — .09 | | |
| 120, 000 | | | | .10 | — .10 | | |
| 130, 000 | | | | .13 | — .10 | | |
| 140, 000 | | | | .18 | — .10 | | |
| 150, 000 | | | | .34 | — .10 | .01 | |
| 152, 300 | 2, 297 | | | .60 | | | Ultimate strength. |

Failed by horizontal deflection, plus direction.
Fibers crushed at middle, in the vicinity of some knots.

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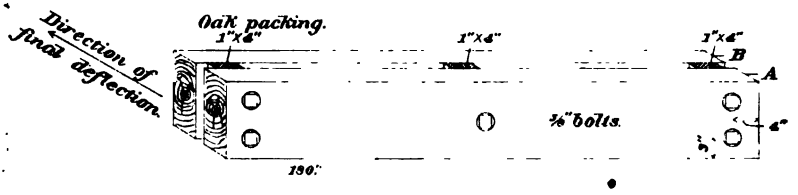
No. 638.




*Preliminary test of the single sticks.*

| Stick. | Weight. | Rings per inch. | Total length. | Width. | Depth. | Sectional area. | Gauged length. |
|---|---|---|---|---|---|---|---|
| | *Pounds.* | | *Inches.* | *Inches.* | *Inches.* | *Sq. inches.* | *Inches.* |
| A | 181 | 6 | 180 | 4.50 | 11.60 | 52.2 | 150 |
| B | 134 | 8 | 180 | 4.50 | 11.59 | 52.2 | 150 |
| | 315 | ..... | ..... | ..... | ..... | 104.4 | ..... |

| Stick. | Loads applied. | | Compression. | Compression set. | Horizontal deflection. |
|---|---|---|---|---|---|
| | Actual. | Pounds per sq. inch. | | | |
| | *Pounds.* | | *Inch.* | *Inch.* | *Inch.* |
| A | 26,100 | 500 | .0670 | (?) | +.02 |
| B | 26,100 | 500 | .0750 | .0002 | —.06 |

*Test of built post.*

| Loads applied. | Deflections. | | | Remarks. |
|---|---|---|---|---|
| | Horizontal. | Vertical, W. | Vertical, E. | |
| *Pounds.* | *Inch.* | *Inch.* | *Inch.* | |
| 10,000 | 0. | 0. | ..... | |
| 20,000 | 0. | 0. | ..... | |
| 40,000 | —.01 | .02 | ..... | |
| 60,000 | —.01 | .02 | ..... | |
| 80,000 | —.02 | .02 | ..... | |
| 100,000 | —.03 | .02 | ..... | |
| 120,000 | —.03 | .02 | ..... | |
| 140,000 | —.04 | .02 | ..... | |
| 160,000 | —.05 | 0. | ..... | |
| 180,000 | —.05 | 0. | ..... | |
| 200,000 | 0. | —.01 | ..... | Ultimate strength = 1,916 pounds per square inch. |

Failed by deflecting horizontally in plus direction. Post changed its direction of bending horizontally at 180,000 pounds.

When the load reached 200,000 pounds, measurement showed zero horizontal deflection. It now took a plus direction, which was increased to +1″.50, when the loads were released.

Under the maximum deflection, fibers of stick B crushed at some knots 15″ from middle.

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## No. 639.

Same style of post as No. 638.

*Preliminary test of the single sticks.*

| Stick. | Weight. | Rings per inch. | Total length. | Width. | Depth. | Sectional area. | Gauged length. |
|---|---|---|---|---|---|---|---|
| | *Pounds.* | | *Inches.* | *Inches.* | *Inches.* | *Sq. inches.* | *Inches.* |
| A | 182 | 7 | 180 | 4.52 | 11.66 | 52.7 | 150 |
| B | 167 | 5 | 180 | 4.49 | 11.62 | 52.2 | 150 |
| | 349 | ..... | ..... | ..... | ..... | 104.9 | ..... |

| Stick. | Loads applied. | | Compression. | Compression set. | Horizontal deflection. |
|---|---|---|---|---|---|
| | Actual. | Pounds per sq. inch. | | | |
| | *Pounds.* | | *Inch.* | *Inch.* | *Inch.* |
| A | 26,350 | 500 | .0645 | .0002 | − .03 |
| B | 26,100 | 500 | .0670 | .0004 | − .02 |

*Test of built post.*

| Loads applied. | Deflections. | | | Remarks. |
|---|---|---|---|---|
| | Horizontal. | Vertical, W. | Vertical, E. | |
| *Pounds.* | *Inch.* | *Inch.* | *Inch.* | |
| 10,000 | 0. | 0. | ..... | |
| 20,000 | 0. | 0. | ..... | |
| 40,000 | 0. | 0. | ..... | |
| 60,000 | 0. | 0. | ..... | |
| 80,000 | 0. | 0. | ..... | |
| 100,000 | 0. | 0. | ..... | |
| 120,000 | 0. | 0. | ..... | |
| 140,000 | 0. | 0. | ..... | |
| 160,000 | 0. | 0. | ..... | |
| 180,000 | − .02 | 0. | ..... | |
| 200,000 | − .08 | 0. | ..... | |
| 212,000 | − .45 | ..... | ..... | Ultimate strength = 2,021 pounds per square inch. |

Failed by horizontal deflection in minus direction. Crushed fibers of stick B at middle.

The deflections increase rapidly soon after the first indications of final failure appear.

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## No. 640.

Same style of post as No. 638.

*Preliminary test of the single sticks.*

| Stick. | Weight. | Rings per inch. | Total length. | Width. | Depth. | Sectional area. | Gauged length. |
|---|---|---|---|---|---|---|---|
| | *Pounds.* | | *Inches.* | *Inches.* | *Inches.* | *Sq. inches.* | *Inches.* |
| A | 131 | 7 | 180 | 4.53 | 11.59 | 5.25 | 150 |
| B | 158 | 5 | 180 | 4.52 | 11.59 | 5.25 | 150 |
| | 289 | ..... | ..... | ..... | ..... | 10.50 | ..... |

| Stick. | Loads applied. | | Compression. | Compression set. | Horizontal deflection. |
|---|---|---|---|---|---|
| | Actual. | Pounds per sq. inch. | | | |
| | *Pounds.* | | *Inch.* | *Inch.* | *Inch.* |
| A | 26,250 | 500 | .1060 | .0015 | + .05 |
| B | 26,250 | 500 | .0955 | .0010 | − .10 |

*Test of built post.*

| Loads applied. | Deflections. | | | Remarks. |
|---|---|---|---|---|
| | Horizontal. | Vertical, W. | Vertical, E. | |
| *Pounds.* | *Inch.* | *Inch.* | *Inch.* | |
| 10,000 | 0. | 0. | ..... | |
| 20,000 | 0. | 0. | ..... | |
| 40,000 | − .02 | 0. | ..... | |
| 60,000 | − .02 | 0. | ..... | |
| 80,000 | − .02 | 0. | ..... | |
| 100,000 | 0. | 0. | ..... | |
| 120,000 | .01 | 0. | ..... | |
| 140,000 | .18 | 0. | ..... | |
| 149,000 | 1.20 | 0. | ..... | Ultimate strength = 1,419 pounds per square inch. |

**Failed by horizontal deflection in plus direction.**
**Deflections increased rapidly when the maximum load was approached.**

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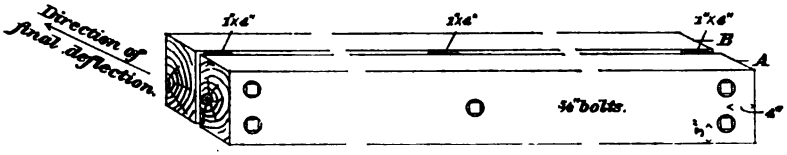
No. 642.




*Preliminary test of single sticks.*

| Stick. | Weight. | Rings per inch. | Total length. | Width. | Depth. | Sectional area. | Gauged length. |
|---|---|---|---|---|---|---|---|
| | *Pounds.* | | *Inches.* | *Inches.* | *Inches.* | *Sq. inches.* | *Inches.* |
| A | 192 | 6 | 179.98 | 5.57 | 11.61 | 64.7 | 150 |
| B | 306 | 7 | 179.98 | 5.58 | 11.61 | 64.7 | 150 |
| | | | | | | 129.4 | |

| Stick. | Loads applied. | | Compression. | Compression. set. | Horizontal deflection. | Permanent horizontal deflection. |
|---|---|---|---|---|---|---|
| | Actual. | Pounds per square inch. | | | | |
| | *Pounds.* | | *Inch.* | *Inch.* | *Inch.* | *Inch.* |
| A | 32,350 | 500 | .0770 | .0006 | .07 | 0. |
| B | 32,350 | 500 | .0390 | — .0007 | .08 | .05 |

*Test of built post.*

| Loads applied. | Deflections. | | | Remarks. |
|---|---|---|---|---|
| | Horizontal. | Vertical, W. | Vertical, E. | |
| *Pounds.* | *Inch.* | *Inch.* | *Inch.* | |
| 10,000 | 0. | 0. | ..... | |
| 20,000 | 0. | 0. | ..... | |
| 40,000 | 0. | 0. | ..... | |
| 60,000 | 0. | .01 | ..... | |
| 80,000 | 0. | .02 | ..... | |
| 100,000 | 0. | .03 | ..... | |
| 120,000 | .01 | .04 | ..... | |
| 140,000 | .03 | .04 | ..... | |
| 150,000 | .04 | .04 | ..... | |
| 160,000 | .06 | .04 | ..... | |
| 170,000 | .08 | .04 | ..... | |
| 180,000 | .10 | .04 | ..... | |
| 190,000 | .11 | .02 | ..... | |
| 200,000 | .18 | .01 | ..... | |
| 210,000 | .32 | 0. | ..... | |
| 215,000 | .72 | — .03 | ..... | Ultimate strength. |

Failed by horizontal deflection in plus direction.

Deflections continued to 1″.15 horizontal, the fibers of stick A crushing in the vicinity of knots 16″ and 48″ from end.

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643.

Same style of post as No. 642.

*Preliminary test of the single sticks.*

| Stick. | Weight | Rings per inch. | Total length. | Width. | Depth. | Sectional area. | Gauged length. |
|---|---|---|---|---|---|---|---|
| | *Pounds.* | | *Inches.* | *Inches.* | *Inches.* | *Sq. inches.* | *Inches.* |
| A | 203 | 17 | 179.92 | 5.65 | 11.61 | 65.6 | 150 |
| B | 189 | 5 | 179.92 | 5.61 | 11.62 | 65.2 | 150 |
| | 392 | | | | | 130.8 | |

| Stick. | Loads applied. Actual. | Loads applied. Pounds per square inch. | Compression. | Compression set. | Horizontal deflection. | Permanent horizontal deflection. |
|---|---|---|---|---|---|---|
| | *Pounds.* | | *Inch.* | *Inch.* | *Inch.* | *Inch.* |
| A | 32,800 | 500 | .0440 | 0. | .02 | — .01 |
| B | 32,600 | 500 | .0600 | .0008 | — .02 | — .02 |

*Test of built post.*

| Loads applied. | Deflections. Horizontal. | Deflections. Vertical, W. | Deflections. Vertical, E. | Remarks. |
|---|---|---|---|---|
| *Pounds.* | *Inch.* | *Inch.* | *Inch.* | |
| 10,000 | .0 | 0. | | |
| 20,000 | .0 | 0. | | |
| 40,000 | — .01 | .05 | | |
| 60,000 | — .01 | .08 | | |
| 80,000 | — .01 | .10 | | |
| 100,000 | — .01 | .12 | | |
| 120,000 | — .01 | .12 | | |
| 140,000 | — .02 | .13 | | |
| 160,000 | — .02 | .14 | | |
| 180,000 | — .02 | .16 | | |
| 200,000 | — .05 | .18 | | |
| 220,000 | — .07 | .20 | | |
| 230,000 | — .09 | .21 | | |
| 240,000 | — .10 | .22 | | |
| 250,000 | — .15 | .25 | | |
| 255,000 | — .19 | .25 | | |
| 260,000 | — .29 | .29 | | |
| 261,000 | — .45 | .30 | | Ultimate strength = 1,995 lbs. per square inch. |

**Failed by deflecting horizontally in minus direction and upward. The deflection was increased horizontally to 1″.20 with changing the vertical.**

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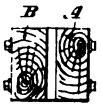
## No. 644.

Same style of post as No. 642.




*Preliminary test of single sticks.*

| Stick. | Weight. | Rings per inch. | Total length. | Width. | Depth. | Sectional area. | Gauged length. |
|---|---|---|---|---|---|---|---|
| | *Pounds.* | | *Inches.* | *Inches.* | *Inches.* | *Sq. inches.* | *Inches.* |
| A | 227 | 7 | 179.96 | 5.60 | 11.63 | 65.1 | 150 |
| B | 236 | 7 | 179.96 | 5.60 | 11.62 | 65.1 | 150 |
| | 463 | ..... | ..... | ..... | ..... | 130.2 | ..... |

| Stick. | Loads applied. | | Compression. | Compression set. | Horizontal deflection. | Permanent horizontal deflection. |
|---|---|---|---|---|---|---|
| | Actual. | Pounds per sq. inch. | | | | |
| | *Pounds.* | | *Inch.* | *Inch.* | *Inch.* | *Inch.* |
| A | 32,550 | 500 | .0596 | 0. | —.02 | —.02 |
| B | 32,550 | 500 | .0690 | .0005 | .02 | —.01 |

*Test of the built post.*

| Loads applied. | Deflections. | | | Remarks. |
|---|---|---|---|---|
| | Horizontal. | Vertical, W. | Vertical, E. | |
| *Pounds.* | *Inch.* | *Inch.* | *Inch.* | |
| 10,000 | 0. | 0. | ..... | |
| 20,000 | 0. | 0. | ..... | |
| 40,000 | 0. | .02 | ..... | |
| 60,000 | 0. | .03 | ..... | |
| 80,000 | —.01 | .05 | ..... | |
| 100,000 | —.01 | .06 | ..... | |
| 120,000 | —.01 | .06 | ..... | |
| 140,000 | —.01 | .09 | ..... | |
| 160,000 | —.03 | .10 | ..... | |
| 180,000 | —.04 | .10 | ..... | |
| 200,000 | —.06 | .11 | ..... | |
| 210,000 | —.08 | .11 | ..... | |
| 220,000 | —.09 | .12 | ..... | |
| 230,000 | —.10 | .13 | ..... | |
| 240,000 | —.11 | .13 | ..... | |
| 250,000 | —.15 | .14 | ..... | |
| 255,000 | —.20 | .13 | ..... | |
| 257,800 | —.45 | .05 | ..... | Ultimate strength = 1,980 pounds per square inch. |

**Failed by horizontal deflection in minus direction. Crushed fibers of stick A 12″ from end, and stick B at middle.**

**The fibers crushing in each case in the vicinity of knots.**

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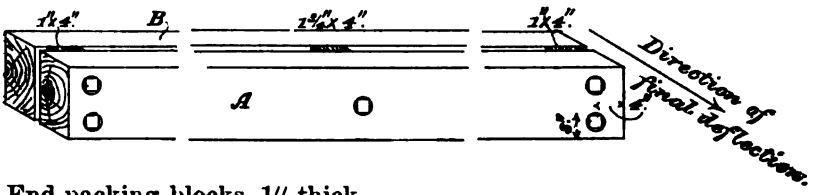
No. 648.

Swelled white-pine built post.




End packing blocks, 1″ thick.
Middle packing block, 1¾″ thick.

*Preliminary test of the single sticks.*

| Stick. | Weight. | Rings per inch. | Total length. | Width. | Depth. | Sectional area. | Gauged length. |
|---|---|---|---|---|---|---|---|
| | *Pounds.* | | *Inches.* | *Inches.* | *Inches.* | *Sq. inches* | *Inches.* |
| A | 206 | 12 | 180 | 5.60 | 11.72 | 65.6 | 150 |
| B | 203 | 10 | 180 | 5.61 | 11.72 | 65.6 | 150 |
| | 409 | ..... | ..... | ..... | ..... | 131.2 | ..... |

| Stick. | Loads applied. | | Compression. | Compression set. | Horizontal deflection. | Permanent horizontal deflection. |
|---|---|---|---|---|---|---|
| | Actual. | Pounds per sq. inch. | | | | |
| | *Pounds.* | | *Inch.* | *Inch.* | *Inch.* | *Inch.* |
| A | 32,800 | 500 | .0590 | .0002 | .19 | .04 |
| B | 32,800 | 500 | .0700 | 0. | .05 | .02 |

Transversely stick A is the stiffer of the two. When the post is bolted up, A deflects ″.34; B deflects ″.41.

*Test of built post.*

| Loads applied. | Deflections. | | | Remarks. |
|---|---|---|---|---|
| | Horizontal. | Vertical, W. | Vertical, E. | |
| *Pounds.* | *Inch.* | *Inch.* | *Inch.* | |
| 10,000 | 0. | 0. | ..... | |
| 20,000 | 0. | 0. | ..... | |
| 40,000 | 0. | 0. | ..... | |
| 60,000 | —.01 | 0. | ..... | |
| 80,000 | —.02 | 0. | ..... | |
| 100,000 | —.05 | 0. | ..... | |
| 120,000 | —.07 | 0. | ..... | |
| 140,000 | —.08 | 0. | ..... | |
| 160,000 | —.10 | 0. | ..... | |
| 180,000 | —.13 | —.02 | ..... | |
| 200,000 | —.17 | —.04 | ..... | |
| 210,000 | —.19 | —.06 | ..... | |
| 220,000 | —.21 | —.06 | ..... | |
| 230,000 | —.23 | —.08 | ..... | |
| 240,000 | —.23 | —.10 | ..... | |
| 250,000 | —.19 | —.18 | ..... | |
| 260,000 | —.07 | —.25 | ..... | |
| 268,000 | ..... | ..... | ..... | Ultimate strength. |

Stick B failed. Fibers crushed at a group of 5 knots 14″ from middle. Size of largest knot, 1½″ diameter.

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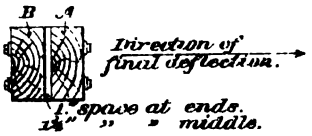
## No. 649.

Same style of post as No. 648.




*Preliminary test of the single sticks.*

| Stick. | Weight. | Rings per inch. | Total length. | Width. | Depth. | Sectional area. | Gauged length. |
|---|---|---|---|---|---|---|---|
| | *Pounds.* | | *Inches.* | *Inches.* | *Inches.* | *Sq. inches.* | *Inches.* |
| A | 187 | 9 | 180 | 5.60 | 11.71 | 65.6 | 150 |
| B | 184 | 4 | 180 | 5.61 | 11.74 | 65.9 | 150 |
| | 371 | ..... | ..... | ..... | ..... | 131.5 | ..... |

| Stick. | Loads applied. | | Compression. | Compression set. | Horizontal deflection. | Permanent horizontal deflection. |
|---|---|---|---|---|---|---|
| | Actual. | Pounds per sq. inch. | | | | |
| | *Pounds.* | | *Inch.* | *Inch.* | *Inch.* | *Inch* |
| A | 32,800 | 500 | .0600 | .0002 | — .19 | — .03 |
| B | 32,950 | 500 | .0705 | .0008 | .34 | .05 |

*Test of the built post.*

Transversely when the post is bolted up.
Stick A deflects ".39." } Middle bolt has washers 4" diameter.
Stick B deflects ".36." }

| Loads applied. | Deflections. | | | Remarks. |
|---|---|---|---|---|
| | Horizontal. | Vertical, W. | Vertical, E. | |
| *Pounds.* | *Inch.* | *Inch.* | *Inch.* | |
| 10,000 | 0. | 0. | ..... | |
| 20,000 | 0. | 0. | ..... | |
| 40,000 | .01 | .01 | ..... | |
| 60,000 | .02 | .02 | ..... | |
| 80,000 | .02 | .02 | ..... | |
| 100,000 | .02 | .05 | ..... | |
| 120,000 | .02 | .08 | ..... | |
| 140,000 | .02 | .09 | ..... | |
| 160,000 | .02 | .10 | ..... | |
| 180,000 | 0. | .11 | ..... | |
| 200,000 | 0. | .12 | ..... | |
| 210,000 | — .01 | .14 | ..... | |
| 220,000 | — .02 | .15 | ..... | |
| 230,000 | — .02 | .16 | ..... | |
| 240,000 | — .05 | .18 | ..... | |
| 250,000 | — .06 | .18 | ..... | |
| 260,000 | — .10 | .20 | ..... | |
| 265,000 | — .15 | .21 | ..... | |
| 270,000 | — .25 | .22 | ..... | |
| 275,000 | — .38 | .24 | ..... | |
| 277,000 | Ab't — .80 | .24 | ..... | Ultimate strength = 2,107 pounds per square inch. |

Failed by horizontal deflection, minus direction.
Fibers of stick A crushed at middle of post.

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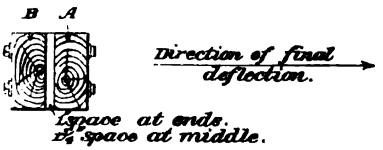
## No. 650.

Same style of post as No. 648.




*Preliminary test of the single sticks.*

| Stick. | Weight. | Rings per inch. | Total length. | Width. | Depth. | Sectional area. | Gauged length. |
|---|---|---|---|---|---|---|---|
| | *Pounds.* | | *Inches.* | *Inches.* | *Inches.* | *Sq inches.* | *Inches.* |
| A | 194 | 12 | 180 | 5.61 | 11.75 | 65.9 | 150 |
| B | 190 | 9 | 180 | 5.61 | 11.71 | 65.7 | 150 |
| | 384 | ..... | ..... | ..... | ..... | 131.6 | ..... |

| Stick. | Loads applied. Actual. | Pounds per square inch. | Compression. | Compression set. | Horizontal deflection. | Permanent horizontal deflection. |
|---|---|---|---|---|---|---|
| | *Pounds.* | | *Inch.* | *Inch.* | *Inch.* | *Inch.* |
| A | 32,950 | 500 | .0530 | 0. | −.22 | −.04 |
| B | 32,850 | 500 | .0885 | .0008 | .17 | .04 |

When bolted together stick A deflected ".32.
When bolted together stick B deflected ".43.

*Test of the built post.*

| Loads applied. | Deflections. Horizontal. | Vertical, W. | Vertical, E. | Remarks. |
|---|---|---|---|---|
| *Pounds.* | *Inch.* | *Inch.* | *Inch.* | |
| 10,000 | 0. | 0. | ..... | |
| 20,000 | 0. | 0. | ..... | |
| 40,000 | −.01 | .01 | ..... | |
| 60,000 | −.04 | .02 | ..... | |
| 80,000 | −.05 | .04 | ..... | |
| 100,000 | −.06 | .04 | ..... | |
| 120,000 | −.07 | .05 | ..... | Post rotated over half revolution. |
| 10,000 | −.01 | 0. | ..... | |
| 50,000 | +.02 | +.01 | ..... | |
| 100,000 | +.06 | +.03 | ..... | |
| 120,000 | +.08 | +.05 | ..... | |
| 140,000 | +.09 | +.06 | ..... | |
| 160,000 | +.10 | +.06 | ..... | |
| 180,000 | +.12 | +.07 | ..... | |
| 200,000 | +.15 | +.09 | ..... | |
| 210,000 | +.20 | +.10 | ..... | |
| 220,000 | +.21 | +.10 | ..... | |
| 230,000 | +.26 | +.10 | ..... | |
| 240,000 | +.31 | +.10 | ..... | Ultimate strength = 1,824 pounds per square inch. |

Failed by horizontal deflection, stick B being on the concave side.
Fibers of each stick crushed at middle in the vicinity of some knots.

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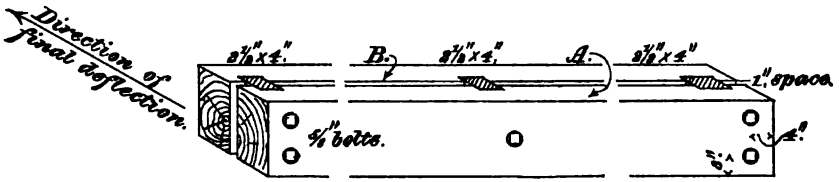
No. 645.




Oak packings let into each stick ¾".

*Preliminary test of the single sticks.*

| Stick. | Weight. | Rings per inch. | Total length. | Width. | Depth. | Sectional area. | Gauged length. |
|---|---|---|---|---|---|---|---|
| | *Pounds.* | | *Inches.* | *Inches.* | *Inches.* | *Sq. inches.* | *Inches.* |
| A | 215 | 5 | 179.97 | 5.59 | 11.59 | 64.8 | 150 |
| B | 266 | 7 | 179.97 | 5.60 | 11.60 | 65.0 | 150 |
| | 481 | ..... | ..... | ..... | ..... | 129.8 | ..... |

| Stick. | Loads applied. Actual. | Loads applied. Pounds per square inch. | Compression. | Compression set. | Horizontal deflection. | Permanent horizontal deflection. |
|---|---|---|---|---|---|---|
| | *Pounds.* | | *Inch.* | *Inch.* | *Inch.* | *Inch.* |
| A | 32,400 | 500 | .0560 | .0006 | −.02 | 0. |
| B | 32,500 | 500 | .0540 | 0. | .02 | 0. |

*Test of the built post.*

| Loads applied. | Deflections. Horizontal. | Deflections. Vertical, W. | Deflections. Vertical, E. | Remarks. |
|---|---|---|---|---|
| *Pounds.* | *Inch.* | *Inch.* | *Inch.* | |
| 10,000 | 0. | 0. | ..... | |
| 20,000 | 0. | 0. | ..... | |
| 40,000 | 0. | .01 | ..... | |
| 60,000 | 0. | .02 | ..... | |
| 80,000 | 0. | .02 | ..... | |
| 100,000 | 0. | .02 | ..... | |
| 120,000 | 0. | .01 | ..... | |
| 140,000 | 0. | .01 | ..... | |
| 160,000 | 0. | .01 | ..... | |
| 180,000 | 0. | 0. | ..... | |
| 200,000 | .01 | .01 | ..... | |
| 210,000 | .01 | .01 | ..... | |
| 220,000 | .01 | .01 | ..... | |
| 230,000 | .01 | .01 | ..... | |
| 240,000 | .02 | .01 | ..... | |
| 250,000 | .05 | .01 | ..... | |
| 260,000 | .10 | .01 | ..... | |
| 263,200 | .30 | .01 | ..... | Ultimate strength = 2,028 pounds per square inch. |

Failed by horizontal deflection in plus direction.

Fibers of both sticks crushed at middle, where bolt passes through, and where the sticks are further weakened by cutting away ¾" of wood to receive packing block.

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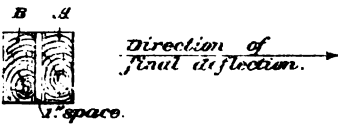
## No. 646.

Same style of post as No. 645.




*Preliminary test of the single sticks.*

| Stick. | Weight. | Rings per inch. | Total length. | Width. | Depth. | Sectional area. | Gauged length. |
|---|---|---|---|---|---|---|---|
| | *Pounds.* | | *Inches.* | *Inches.* | *Inches.* | *Sq. inches.* | *Inches.* |
| A | 206 | 6 | 180 | 5.59 | 11.61 | 64.9 | 150 |
| B | 204 | 12 | 180 | 5.60 | 11.62 | 65.1 | 150 |
| | 410 | ..... | ..... | ..... | ..... | 130.0 | ..... |

| Stick. | Loads applied. | | Compression. | Compression set. | Horizontal deflection. | Permanent horizontal deflection. |
|---|---|---|---|---|---|---|
| | Actual. | Pounds per square inch. | | | | |
| | *Pounds.* | | *Inch.* | *Inch.* | *Inch.* | *Inch.* |
| A | 32,450 | 500 | .0493 | 0. | 0. | — .01 |
| B | 32,550 | 500 | .0620 | .0005 | — .02 | — .01 |

*Test of the built post.*

| Loads applied. | Deflections. | | | Remarks. |
|---|---|---|---|---|
| | Horizontal. | Vertical, W. | Vertical, E. | |
| *Pounds.* | *Inch.* | *Inch.* | *Inch.* | |
| 10,000 | 0. | 0. | ..... | |
| 20,000 | 0. | .02 | ..... | |
| 40,000 | 0. | .05 | ..... | |
| 60,000 | 0. | .06 | ..... | |
| 80,000 | 0. | .07 | ..... | |
| 100,000 | 0. | .07 | ..... | |
| 120,000 | 0. | .07 | ..... | |
| 140,000 | 0. | .08 | ..... | |
| 160,000 | — .01 | .08 | ..... | |
| 180,000 | — .02 | .08 | ..... | |
| 200,000 | — .03 | .08 | ..... | |
| 210,000 | — .05 | .08 | ..... | |
| 220,000 | — .07 | .08 | ..... | |
| 230,000 | — .11 | .08 | ..... | |
| 240,000 | — .20 | .07 | ..... | |
| 249,000 | — .42 | .02 | ..... | Ultimate strength = 1,915 lbs. per square inch. |

Failed by horizontal deflection in minus direction.

The post took a sharp bend at the middle, crushing the fibers of stick B, and splitting stick A at the middle packing block.

Stick A crushed the fibers 10″ from end in the vicinity of knots.

During the preliminary test of the single sticks an end section (2″ × 11″.61) beyond the notched recess for packing block was accidentally split off. This piece was nailed on again. It passed through the test without disturbance, showing that it carried very little shearing load when tested in this manner between flat rigid platforms.

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## No. 647.

Same style of post as No. 645.

*Preliminary test of the single sticks.*

| Stick. | Weight. | Rings per inch. | Total length. | Width. | Depth. | Sectional area. | Gauged length. |
|---|---|---|---|---|---|---|---|
| | *Pounds.* | | *Inches.* | *Inches.* | *Inches.* | *Sq. inches.* | *Inches.* |
| A | 192 | 11 | 180 | 5.62 | 11.62 | 65.3 | 150 |
| B | 192 | 13 | 180 | 5.62 | 11.62 | 65.3 | 150 |
| | 384 | | | | | 130.6 | |

| Stick. | Loads applied. Actual. | Loads applied. Pounds per square inch. | Compression. | Compression set. | Horizontal deflection. | Permanent horizontal deflection. |
|---|---|---|---|---|---|---|
| | *Pounds.* | | *Inch.* | *Inch.* | *Inch.* | *Inch.* |
| A | 32,650 | 500 | .0630 | .0006 | 0. | —.01 |
| B | 32,650 | 500 | .0700 | .0005 | .08 | 0. |

*Test of the built post.*

| Loads applied. | Deflections. Horizontal. | Deflections. Vertical, W. | Deflections. Vertical, E. | Remarks. |
|---|---|---|---|---|
| *Pounds.* | *Inch.* | *Inch.* | *Inch.* | |
| 10,000 | 0. | 0. | | |
| 20,000 | 0. | 0. | | |
| 40,000 | 0. | 0. | | |
| 60,000 | 0. | 0. | | |
| 80,000 | —.02 | .01 | | |
| 100,000 | —.05 | .01 | | |
| 120,000 | —.06 | .02 | | |
| 140,000 | —.07 | .03 | | |
| 160,000 | —.10 | .05 | | |
| 180,000 | —.11 | .06 | | |
| 200,000 | —.15 | .08 | | |
| 210,000 | —.19 | .10 | | |
| 220,000 | —.20 | .10 | | |
| 230,000 | —.26 | .11 | | |
| 240,000 | —.35 | .12 | | |
| 248,000 | —.72 | .15 | | Ultimate strength = 1,899 pounds per square inch. |

Failed by horizontal deflection in minus direction.
Stick A split fibers at middle.

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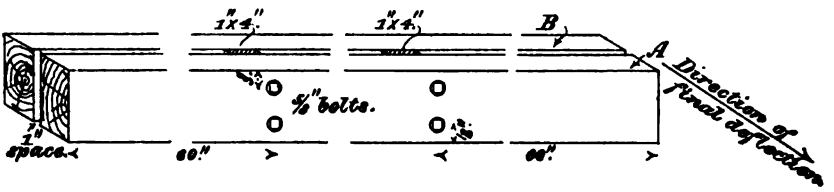
No. 678.




*Preliminary test of the single sticks.*

| Stick. | Weight. | Rings per inch. | Total length. | Width. | Depth. | Sectional area. | Gauged length. |
|---|---|---|---|---|---|---|---|
| | *Pounds.* | | *Inches.* | *Inches.* | *Inches.* | *Sq. inches.* | *Inches.* |
| A | 251 | 16 | 179.94 | 5.58 | 11.47 | 64.0 | 150 |
| B | 215 | 8 | 179.94 | 5.57 | 11.45 | 63.8 | 150 |
| | 466 | ..... | ..... | ..... | ..... | 127.8 | ..... |

| Stick. | Loads applied. | | Compression. | Compression set. | Horizontal deflection. | Permanent horizontal deflection. |
|---|---|---|---|---|---|---|
| | Actual. | Pounds per square inch. | | | | |
| | *Pounds.* | | *Inch.* | *Inch.* | *Inch.* | *Inch.* |
| A | 32,000 | 500 | .0529 | 0. | 0. | 0. |
| B | 31,900 | 500 | .0642 | .0005 | —.07 | .01 |

*Test of the built post.*

| Loads applied. | Deflections. | | | Remarks. |
|---|---|---|---|---|
| | Horizontal. | Vertical, W. | Vertical, E. | |
| *Pounds.* | *Inch.* | *Inch.* | *Inch.* | |
| 10,000 | 0. | 0. | 0. | |
| 20,000 | 0. | —.01 | ..... | |
| 40,000 | —.01 | —.02 | ..... | |
| 60,000 | —.03 | —.03 | ..... | |
| 80,000 | —.05 | —.04 | ..... | |
| 100,000 | —.06 | —.05 | .05 | |
| 120,000 | —.07 | —.05 | ..... | |
| 140,000 | —.09 | —.06 | ..... | |
| 160,000 | —.10 | —.07 | ..... | |
| 180,000 | —.13 | —.08 | ..... | |
| 200,000 | —.16 | —.09 | .10 | |
| 220,000 | —.21 | —.10 | ..... | |
| 230,000 | —.27 | —.10 | ..... | |
| 240,000 | —.36 | —.11 | ..... | |
| 245,500 | —.57 | —.14 | ..... | Ultimate strength = 1,921 pounds per square inch. |

Failed by horizontal deflection, minus direction.

Fibers crushed near the south end of post at some knots.

Stick A fa led 8″ from end, stick B 2″ from end and at bolt-holes, which were bored alongside a knot.

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## No. 679.

Same style of post as No. 678.

*Preliminary test of the single sticks.*

| Stick. | Weight. | Rings per inch. | Total length. | Width. | Depth. | Sectional area. | Gauged length. |
|---|---|---|---|---|---|---|---|
| | *Pounds.* | | *Inches.* | *Inches.* | *Inches.* | *Sq. inches.* | *Inches.* |
| A | 209 | 12 | 180 | 5.62 | 11.76 | 66.1 | 150 |
| B | 190 | 7 | 180 | 5.62 | 11.72 | 65.9 | 150 |
| | 399 | ..... | ..... | ..... | ..... | 132.0 | ..... |

| Stick. | Loads applied. | | Compression. | Compression set. | Horizontal deflection. | Permanent horizontal deflection. |
|---|---|---|---|---|---|---|
| | Actual. | Pounds per square inch. | | | | |
| | *Pounds.* | | *Inch.* | *Inch.* | *Inch.* | *Inch.* |
| A | 33,050 | 500 | .0664 | .0010 | .05 | 0. |
| B | 32,950 | 500 | .0705 | .0003 | — .05 | — .01 |

*Test of the built post.*

| Loads applied. | Deflections. | | | Remarks. |
|---|---|---|---|---|
| | Horizontal. | Vertical, W. | Vertical, E. | |
| *Pounds.* | *Inch.* | *Inch.* | *Inch.* | |
| 10,000 | 0. | 0. | 0. | |
| 20,000 | 0. | 0. | ..... | |
| 40,000 | 0. | 0. | ..... | |
| 60,000 | 0. | 0. | ..... | |
| 80,000 | 0. | .01 | ..... | |
| 100,000 | 0. | .01 | .04 | |
| 120,000 | 0. | .02 | ..... | |
| 140,000 | 0. | .04 | ..... | |
| 160,000 | 0. | .05 | ..... | |
| 180,000 | 0. | .05 | ..... | |
| 200,000 | 0. | .06 | .10 | |
| 210,000 | .01 | .07 | ..... | |
| 220,000 | .01 | .07 | ..... | |
| 230,000 | .02 | .08 | ..... | |
| 240,000 | .02 | .08 | ..... | |
| 249,000 | .05 | .08 | ..... | Ultimate strength = 1,886 lbs. per square inch. |

Stick A failed at bolt-holes. Stick B failed at bolt-holes and at a group of knots 12″ from bolt-holes.



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## No. 680.

Same style of post as No. 678.

*Preliminary test of the single sticks.*

| Stick. | Weight. | Rings per inch. | Total length. | Width. | Depth. | Sectional area. | Gauged length. |
|---|---|---|---|---|---|---|---|
| | *Pounds.* | | *Inches.* | *Inches.* | *Inches.* | *Sq. inches.* | *Inches.* |
| A | 268 | 8 | 180 | 5.60 | 11.72 | 65.6 | 150 |
| B | 278 | 8 | 180 | 5.61 | 11.72 | 65.8 | 150 |
| | 546 | ..... | ..... | ..... | ..... | 131.4 | ..... |

| Stick. | Loads applied. | | Compression. | Compression set. | Horizontal deflection. | Permanent horizontal deflection. |
|---|---|---|---|---|---|---|
| | Actual. | Pounds per square inch. | | | | |
| | *Pounds.* | | *Inch.* | *Inch.* | *Inch.* | *Inch.* |
| A | 32,800 | 500 | .0650 | .0009 | —.03 | 0. |
| B | 32,900 | 500 | .0495 | 0. | 3. | —.02 |

*Test of the built post.*

| Loads applied. | Deflection. | | | Remarks. |
|---|---|---|---|---|
| | Horizontal. | Vertical, W. | Vertical, E. | |
| *Pounds.* | *Inch.* | *Inch.* | *Inch.* | |
| 10,000 | 0. | 0. | 0. | |
| 20,000 | 0. | 0. | ..... | |
| 40,000 | 0. | 0. | ..... | |
| 60,000 | 0. | 0. | ..... | |
| 80,000 | 0. | 0. | ..... | |
| 100,000 | 0. | 0. | 0. | |
| 120,000 | 0. | 0. | ..... | |
| 140,000 | 0. | 0. | ..... | |
| 160,000 | 0. | 0. | ..... | |
| 180,000 | 0. | 0. | ..... | |
| 200,000 | 0. | 0. | .05 | |
| 210,000 | 0. | 0. | ..... | |
| 220,000 | 0. | 0. | ..... | |
| 230,000 | 0. | 0. | ..... | |
| 240,000 | 0. | 0. | ..... | |
| 250,000 | 0. | 0. | ..... | |
| 260,000 | —.01 | 0. | ..... | |
| 270,000 | —.02 | 0. | ..... | |
| 278,000 | ..... | ..... | ..... | Ultimate strength = 2,116 lbs. per square inch. |

Stick A failed at knots 40″ and 66″ from end. Stick B failed at knots 12″ from middle.

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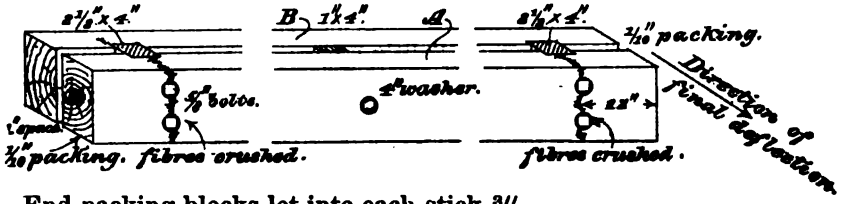
No. 663.




End packing blocks let into each stick $\frac{3}{4}$".

*Preliminary test of the single sticks.*

| Stick. | Weight. | Rings per inch. | Total length. | Width. | Depth. | Sectional area. | Gauged length. |
|---|---|---|---|---|---|---|---|
| | *Pounds.* | | *Inches.* | *Inches.* | *Inches.* | *Sq. inches.* | *Inches.* |
| A | 230 | 14 | 180 | 5.60 | 11.75 | 65.8 | 150 |
| B | 208 | 6 | 180 | 5.63 | 11.75 | 66.2 | 150 |
| | 438 | ..... | ..... | ..... | ..... | 122.0 | ..... |

| Stick. | Loads applied. | | Compression. | Compression set. | Horizontal deflection. | Permanent horizontal deflection. |
|---|---|---|---|---|---|---|
| | Actual. | Pounds per square inch. | | | | |
| | *Pounds.* | | *Inch.* | *Inch.* | *Inch.* | *Inch.* |
| A | 32,900 | 500 | .0621 | .0005 | .02 | —.01 |
| B | 33,100 | 500 | .0657 | .0010 | —.06 | 0. |

*Test of the built post.*

Tested with uneven bearings.

Yellow-pine strip ".1 thick placed behind north end of stick A. Same amount of packing placed behind south end of stick B.

| Loads applied. | Deflections. | | | Remarks. |
|---|---|---|---|---|
| | Horizontal. | Vertical, W. | Vertical, E. | |
| *Pounds.* | *Inch.* | *Inch.* | *Inch.* | |
| 10,000 | 0. | 0. | 0. | |
| 20,000 | —.01 | 0. | ..... | Ends not packed came to full bearing. |
| 30,000 | —.03 | 0. | ..... | |
| 40,000 | —.03 | 0. | ..... | |
| 60,000 | —.04 | 0. | ..... | |
| 80,000 | —.05 | 0. | ..... | |
| 100,000 | —.05 | 0. | ..... | |
| 120,000 | —.05 | 0. | —.01 | |
| 140,000 | —.05 | 0. | ..... | |
| 160,000 | —.05 | 0. | ..... | |
| 180,000 | —.05 | +.01 | ..... | |
| 200,000 | —.05 | +.01 | —.05 | |
| 210,000 | —.03 | +.01 | ..... | |
| 220,000 | —.03 | +.01 | ..... | |
| 230,000 | —.01 | +.01 | ..... | |
| 240,000 | 0. | +.01 | ..... | |
| 250,000 | +.01 | .02 | —.07 | |
| 260,000 | .07 | .02 | ..... | |
| 270,000 | .09 | .02 | ..... | |
| 280,000 | .02 | —.01 | —.07 | |
| 290,000 | —.01 | —.02 | ..... | |
| 300,000 | —.21 | —.05 | ..... | Ultimate strength=2,273 pounds per square inch. |

Final deflection took place in minus horizontal direction. Loads were continued after passing the maximum till the horizontal deflection was

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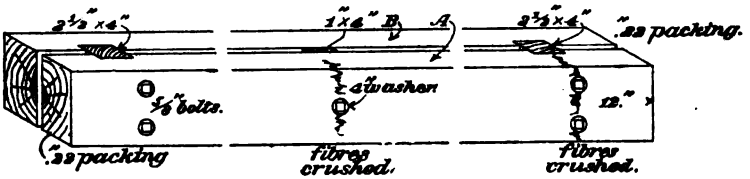
increased to —1″.10, developing lines of failure by crushing the fibers at the notched ends of stick A.

No. 676.




*Preliminary test of the single sticks.*

| Stick. | Weight. | Rings per inch. | Total length. | Width. | Depth. | Sectional area. | Gauged length. |
|---|---|---|---|---|---|---|---|
| | *Pounds.* | | *Inches.* | *Inches.* | *Inches.* | *Sq. inches.* | *Inches.* |
| A | 201 | 12 | 179.94 | 5.60 | 11.71 | 65.6 | 150 |
| B | 184 | 6 | 179.94 | 5.61 | 11.73 | 65.8 | 150 |
| | 385 | ..... | ..... | ..... | ..... | 131.4 | ..... |

| Stick. | Loads applied. | | Compression. | Compression set. | Horizontal deflection. | Permanent horizontal deflection. |
|---|---|---|---|---|---|---|
| | Actual. | Pounds per square inch. | | | | |
| | *Pounds.* | | *Inch.* | *Inch.* | *Inch.* | *Inch.* |
| A | 32,800 | 500 | .0580 | .0003 | .06 | .01 |
| B | 32,900 | 500 | .0593 | 0. | —.05 | 0. |

*Test of the built post.*

Tested with uneven bearings.

Strip of yellow pine ″.22 thick placed behind north end of stick A. Same amount of packing placed behind south end of stick B.

| Loads applied. | Deflections. | | | Remarks. |
|---|---|---|---|---|
| | Horizontal. | Vertical, W. | Vertical, E. | |
| *Pounds.* | *Inch.* | *Inch.* | *Inch.* | |
| 10,000 | 0. | 0. | 0. | |
| 20,000 | —.05 | +.01 | ..... | North end of stick B reached a full bearing at 26,000 pounds. |
| 30,000 | —.10 | +.01 | ..... | |
| 40,000 | —.13 | +.01 | ..... | |
| 50,000 | —.12 | +.01 | ..... | South end of stick A reached a bearing at 33,000 pounds.. |
| 60,000 | —.12 | +.02 | ..... | |
| 80,000 | —.11 | +.03 | ..... | |
| 100,000 | —.09 | +.05 | —.04 | |
| 120,000 | —.08 | .09 | ..... | |
| 140,000 | —.07 | .10 | ..... | |
| 160,000 | —.06 | .11 | ..... | |
| 180,000 | —.05 | .11 | ..... | |
| 200,000 | —.04 | .11 | —.06 | |
| 220,000 | —.04 | .11 | ..... | |
| 230,000 | —.03 | .10 | ..... | |
| 240,000 | —.05 | .10 | ..... | |
| 250,000 | —.06 | .10 | ..... | |
| 260,000 | —.09 | .08 | ..... | |
| 270,000 | —.10 | .08 | ..... | |
| 274,500 | —.11 | ..... | ..... | Ultimate strength = 2,089 pounds per square inch. |

Failed by crushing the fibers of stick A at notch 12″ from south end and at the middle.

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## No. 677.

Same style of post as No. 676.

1" space.

*Preliminary test of the single sticks.*

| Stick. | Weight. | Rings per inch. | Total length. | Width. | Depth. | Sectional area. | Gauged length. |
|---|---|---|---|---|---|---|---|
| | *Pounds.* | | *Inches.* | *Inches.* | *Inches.* | *Sq. inches.* | *Inches.* |
| A | 185 | 6 | 180 | 5.61 | 11.72 | 65.7 | 150 |
| B | 193 | 6 | 180 | 5.58 | 11.72 | 65.4 | 150 |
| | 378 | ..... | ..... | ..... | ..... | 131.1 | ..... |

| Stick. | Loads applied. | | Compression. | Compression set. | Horizontal deflection. | Permanent horizontal deflection. |
|---|---|---|---|---|---|---|
| | Actual. | Pounds per square inch. | | | | |
| | *Pounds.* | | *Inch.* | *Inch.* | *Inch.* | *Inch.* |
| A | 32,850 | 500 | .0551 | .0004 | .07 | 0. |
| B | 32,700 | 500 | .0625 | .0005 | — .08 | ..... |

*Test of the built post.*

Tested with uneven bearings. Yellow-pine stick ".32 thick placed behind north end of stick A. Same amount of packing used behind south end of stick B.

| Loads applied. | Deflections. | | | Remarks. |
|---|---|---|---|---|
| | Horizontal. | Vertical, W. | Vertical, E. | |
| *Pounds.* | *Inch.* | *Inch.* | *Inch.* | |
| 10,000 | 0. | 0. | 0. | |
| 20,000 | — .01 | .01 | ..... | |
| 30,000 | — .06 | .04 | ..... | |
| 40,000 | — .07 | .04 | ..... | |
| 50,000 | — .07 | .03 | .02 | |
| 60,000 | — .07 | .03 | ..... | |
| 80,000 | — .05 | .03 | ..... | |
| 100,000 | — .03 | .03 | ..... | |
| 120,000 | — .01 | .03 | ..... | |
| 140,000 | — .01 | .04 | ..... | |
| 160,000 | 0. | .02 | ..... | |
| 180,000 | 0. | .04 | ..... | |
| 200,000 | 0. | .04 | ..... | |
| 220,000 | 0. | .04 | ..... | |
| 240,000 | — .01 | .04 | ..... | |
| 250,000 | — .02 | .04 | .07 | |
| 255,000 | .16 | .07 | ..... | Ultimate strength=1,945 pounds per square inch. |

Stick A failed at a group of knots 15" from end.

Stick B failed at knots 40" from end; also fibers crushed where the stick was notched to receive packing block.

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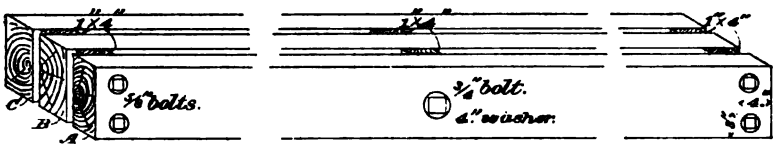
## No. 690.




*Preliminary test of the single sticks.*

| Stick. | Weight. | Rings per inch. | Total length. | Width. | Depth. | Sectional area. | Gauged length. |
|---|---|---|---|---|---|---|---|
| | *Pounds.* | | *Inches.* | *Inches.* | *Inches.* | *Sq. inches.* | *Inches.* |
| A | 175 | 18 | 180 | 4.52 | 11.62 | 52.5 | 150 |
| B | 226 | 11 | 180 | 5.56 | 11.70 | 65.0 | 150 |
| C | 199 | 18 | 180 | 4.46 | 11.62 | 51.8 | 150 |
| | 600 | ..... | ..... | ..... | ..... | 169.3 | ..... |

| Stick. | Loads applied. | | Compression. | Compression set. | Horizontal deflection. | Permanent horizontal deflection. |
|---|---|---|---|---|---|---|
| | Actual. | Pounds per square inch. | | | | |
| | *Pounds.* | | *Inch.* | *Inch.* | *Inch.* | *Inch.* |
| A | 26,250 | 500 | .0460 | 0. | .18 | .01 |
| B | 32,500 | 500 | .0580 | .0008 | — .02 | 0. |
| C | 25,900 | 500 | .0480 | .0008 | .20 | .02 |

*Test of the built post.*

| Loads applied. | Deflections. | | | Remarks. |
|---|---|---|---|---|
| | Horizontal. | Vertical, W. | Vertical, E. | |
| *Pounds.* | *Inch.* | *Inch.* | *Inch.* | |
| 0 | 0. | 0. | 0. | |
| 20,000 | — .04 | .01 | ..... | |
| 40,000 | — .07 | .03 | ..... | |
| 60,000 | — .06 | .03 | ..... | |
| 80,000 | — .05 | .05 | ..... | |
| 100,000 | .05 | .05 | .05 | |
| 140,000 | .04 | .06 | ..... | |
| 180,000 | .03 | .07 | ..... | |
| 200,000 | .02 | .08 | .08 | |
| 220,000 | 0. | .09 | ..... | |
| 240,000 | 0. | .10 | ..... | |
| 260,000 | — .02 | .11 | ..... | |
| 280,000 | — .06 | .11 | ..... | |
| 300,000 | — .12 | .12 | ..... | |
| 310,000 | — .32 | .16 | ..... | Ultimate strength = 1,831 lbs. per square inch. |

Stick A failed at a knot 54″ from the end of post.
Stick B failed at a knot 33″ from the end of post.

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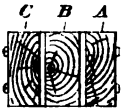
## No. 691.

### Same style of post as No. 690.




1" spaces.

*Preliminary test of the single sticks.*

| Stick. | Weight. | Ring per inch. | Total length. | Width. | Depth. | Sectional area. | Gauged length. |
|---|---|---|---|---|---|---|---|
| | *Pounds.* | | *Inches.* | *Inches.* | *Inches.* | *Sq. inches.* | *Inches.* |
| A | 164 | 9 | 179.98 | 4.48 | 11.60 | 52.0 | 150 |
| B | 197 | 14 | 179.98 | 5.56 | 11.60 | 64.5 | 150 |
| C | 159 | 12 | 179.98 | 4.45 | 11.61 | 51.7 | 150 |
| | 520 | ..... | ..... | ..... | ..... | 168.2 | ..... |

| Stick. | Loads applied. | | Compression. | Compression set. | Horizontal deflection. | Permanent horizontal deflection. |
|---|---|---|---|---|---|---|
| | Actual. | Pounds per square inch. | | | | |
| | *Pounds.* | | *Inch.* | *Inch.* | *Inch.* | *Inch.* |
| A | 26,000 | 500 | .0526 | .0010 | —.15 | 0. |
| B | 32,250 | 500 | .0430 | .0002 | 0. | —.01 |
| C | 25,850 | 500 | .0390 | .0002 | .01 | .01 |

*Test of the built post.*

| Loads applied. | Deflections. | | | Remarks. |
|---|---|---|---|---|
| | Horizontal. | Vertical, W. | Vertical, E. | |
| *Pounds.* | *Inch.* | *Inch.* | *Inch.* | |
| 0 | 0. | 0. | 0. | |
| 20,000 | 0. | .02 | ..... | |
| 40,000 | —.01 | .03 | ..... | |
| 60,000 | —.02 | .03 | ..... | |
| 80,000 | —.02 | .02 | ..... | |
| 100,000 | —.03 | .01 | .07 | |
| 140,000 | —.04 | .01 | ..... | |
| 180,000 | —.06 | 0. | ..... | |
| 200,000 | —.07 | 0. | .10 | |
| 220,000 | —.07 | 0. | ..... | |
| 240,000 | —.08 | 0. | ..... | |
| 260,000 | —.09 | 0. | ..... | |
| 280,000 | —.10 | 0. | ..... | |
| 300,000 | —.11 | 0. | ..... | |
| 310,000 | —.14 | 0. | ..... | |
| 320,000 | —.16 | 0. | ..... | |
| 330,000 | —.17 | 0. | ..... | |
| 340,000 | —.20 | 0. | ..... | |
| 350,000 | —.21 | .01 | ..... | |
| 360,000 | —.28 | .03 | ..... | |
| 372,500 | —.50 | ..... | ..... | Ultimate strength = 2,215 lbs. per square inch. |

Stick A crushed 22" from middle.

Stick C crushed 8" from middle, both failures occurring in the vicinity of knots.

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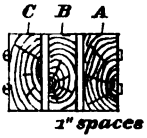
## No. 692.

Same style of post as No. 690, except two outside sticks got out of 6″×12″ timber, middle stick got out of 5″×12″ timber.




*Preliminary test of the single sticks.*

| Stick. | Weight. | Ring per inch. | Total length. | Width. | Depth. | Sectional area. | Gauged length. |
|---|---|---|---|---|---|---|---|
| | *Pounds.* | | *Inches.* | *Inches.* | *Inches.* | *Sq. inches.* | *Inches.* |
| A | 248 | 18 | 177.25 | 5.62 | 11.60 | 65.2 | 150 |
| B | 153 | 12 | 177.25 | 4.59 | 11.60 | 52.2 | 150 |
| C | 213 | 5 | 177.25 | 5.60 | 11.57 | 64.8 | 150 |
| | 614 | ..... | ..... | ..... | ..... | 182.2 | ..... |

| Stick. | Loads applied. | | Compression. | Compression set. | Horizontal deflection. | Permanent horizontal deflection. |
|---|---|---|---|---|---|---|
| | Actual. | Pounds per square inch. | | | | |
| | *Pounds.* | | *Inch.* | *Inch.* | *Inch.* | *Inch.* |
| A | 32,600 | 500 | .0580 | .0001 | .06 | .01 |
| B | 26,100 | 500 | .0641 | .0006 | .08 | .01 |
| C | 32,400 | 500 | .0768 | .0012 | — .06 | 0. |

*Test of the built post.*

| Loads applied. | Deflections. | | | Remarks. |
|---|---|---|---|---|
| | Horizontal. | Vertical, W. | Vertical, E. | |
| *Pounds.* | *Inch.* | *Inch.* | *Inch.* | |
| 0 | 0. | 0. | 0. | |
| 20,000 | 0. | 0. | ..... | |
| 40,000 | 0. | 0. | ..... | |
| 60,000 | .01 | 0. | ..... | |
| 80,000 | .01 | .01 | ..... | |
| 100,000 | .01 | .03 | .05 | |
| 140,000 | .01 | .06 | ..... | |
| 180,000 | 0. | .09 | ..... | |
| 200,000 | 0. | .09 | — .10 | |
| 220,000 | .01 | .10 | ..... | |
| 240,000 | — .02 | .10 | ..... | |
| 260,000 | — .04 | .11 | ..... | |
| 280,000 | — .05 | .12 | ..... | |
| 300,000 | — .07 | .12 | — .15 | |
| 310,000 | — .08 | .13 | ..... | |
| 320,000 | — .07 | .16 | ..... | |
| 330,000 | — .07 | .19 | — .27 | |
| 340,000 | — .09 | .20 | ..... | |
| 350,000 | — .11 | .21 | ..... | |
| 360,000 | — .18 | .21 | ..... | |
| 368,000 | — .89 | .21 | ..... | Ultimate strength=1,992 pounds per square inch. |

Stick C failed at a knot 1¼″ diameter, 10″ from middle.
Stick B failed at a group of knots 8″ from middle.

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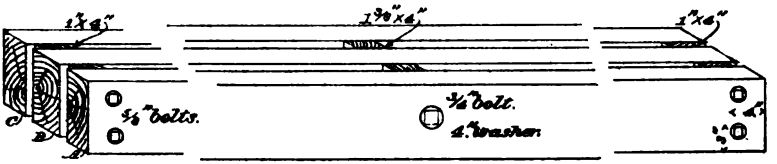
## No. 687.

### SWELLED POST.




1″ spaces at ends.
1⅜″ spaces at middle.

*Preliminary test of the single sticks.*

| Stick. | Weight. | Rings per inch. | Total length. | Width. | Depth. | Sectional area. | Gauged length. |
|---|---|---|---|---|---|---|---|
| | *Pounds.* | | *Inches.* | *Inches.* | *Inches.* | *Sq. inches.* | *Inches.* |
| A | 151 | 11 | 180 | 4.50 | 11.60 | 52.2 | 150 |
| B | 218 | 8 | 180 | 5.58 | 11.62 | 64.8 | 150 |
| C | 167 | 9 | 180 | 4.52 | 11.59 | 52.4 | 150 |
| | 536 | ..... | ..... | ..... | ..... | 169.4 | ..... ..... |

| Stick. | Loads applied. | | Compression. | Compression set. | Horizontal deflection. | Permanent horizontal deflection. |
|---|---|---|---|---|---|---|
| | Actual. | Pounds per square inch. | | | | |
| | *Pounds.* | | *Inch.* | *Inch.* | *Inch.* | *Inch.* |
| A | 26,100 | 500 | .0460 | 0. | —.27 | 0. |
| B | 32,400 | 500 | .0587 | .0007 | .02 | 0. |
| C | 26,200 | 500 | .0533 | .0008 | .25 | .02 |

*Test of the built post.*

| Loads applied. | Deflections. | | | Remarks. |
|---|---|---|---|---|
| | Horizontal. | Vertical, W. | Vertical, E. | |
| *Pounds.* | *Inch.* | *Inch.* | *Inch.* | |
| 0 | 0 | 0. | 0. | |
| 20,000 | .02 | .03 | 0. | |
| 40,000 | .01 | .04 | ..... | |
| 60,000 | .01 | .05 | ..... | |
| 80,000 | .01 | .06 | ..... | |
| 100,000 | .01 | .07 | .03 | |
| 140,000 | 0. | .08 | ..... | |
| 180,000 | 0. | .08 | ..... | |
| 200,000 | —.01 | .08 | .05 | |
| 220,000 | —.01 | .08 | ..... | |
| 240,000 | —.04 | .07 | ..... | |
| 260,000 | —.05 | .08 | ..... | |
| 280,090 | —.08 | .10 | ..... | |
| 300,000 | —.10 | .08 | .07 | |
| 320,000 | —.21 | .09 | ..... | |
| 325,500 | —.34 | .09 | ..... | Ultimate strength = 1,919 pounds per square inch. |

Fibers of stick A failed at a knot 12″ from middle. Stick C crushed fibers at a knot at middle of post.

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## No. 688.

Same style of post as No. 687.

*Preliminary test of the single sticks.*

| Stick. | Weight. | Rings per inch. | Total length. | Width. | Depth. | Sectional area. | Ganged length. |
|---|---|---|---|---|---|---|---|
| | *Pounds.* | | *Inches.* | *Inches.* | *Inches.* | *Sq. inches.* | *Inches.* |
| A | 176 | 10 | 180 | 4.50 | 11.60 | 52.2 | 150 |
| B | 236 | 10 | 180 | 5.62 | 11.60 | 65.2 | 150 |
| C | 163 | 11 | 180 | 4.50 | 11.60 | 52.2 | 150 |
| | 575 | ..... | ..... | ..... | ..... | 169.6 | ..... |

| Stick. | Loads applied. | | Compression. | Compression set. | Horizontal deflection. | Permanent horizontal deflection. |
|---|---|---|---|---|---|---|
| | Actual. | Pounds per sq. inch. | | | | |
| | *Pounds.* | | *Inch.* | *Inch.* | *Inch.* | *Inch.* |
| A | 26,100 | 500 | .0565 | .0002 | —.29 | —.01 |
| B | 32,600 | 500 | .0645 | 0. | —.10 | —.01 |
| C | 26,100 | 500 | .0703 | .0008 | .29 | .03 |

*Test of the built post.*

| Loads applied. | Deflections. | | | Remarks. |
|---|---|---|---|---|
| | Horizontal. | Vertical, W. | Vertical, E. | |
| *Pounds.* | *Inch.* | *Inch.* | *Inch.* | |
| 0 | 0. | 0. | 0. | |
| 20,000 | 0. | 0. | ..... | Sticks A and B have poor appearance; color of wood dull, lifeless. Stick B contains 15 knots from ¾" to 1½" diameter. |
| 40,000 | 0. | .02 | ..... | |
| 60,000 | 0. | .05 | ..... | |
| 80,000 | 0. | .06 | ..... | |
| 100,000 | 0. | .07 | —.08 | |
| 140,000 | —.01 | .08 | ..... | |
| 180,000 | —.01 | .08 | ..... | |
| 200,000 | —.02 | .08 | ..... | |
| 220,000 | —.03 | .08 | ..... | |
| 240,000 | —.04 | .08 | ..... | |
| 260,000 | —.06 | .08 | ..... | |
| 280,000 | —.10 | .06 | ..... | |
| 300,000 | —.21 | .06 | ..... | |
| 306,000 | —.40 | .06 | ..... | Ultimate strength = 1,804 pounds per square inch. |

Failed by horizontal deflection, minus direction. Stick B failed at a knot at middle.

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## No. 689.

Same style of post as No. 687.

*Preliminary test of the single sticks.*

| Stick. | Weight. | Rings per inch. | Total length. | Width. | Depth. | Sectional area. | Gauged length. |
|---|---|---|---|---|---|---|---|
| | *Pounds.* | | *Inches.* | *Inches.* | *Inches.* | *Sq. inches.* | *Inches.* |
| A | 188 | 7 | 180.05 | 4.48 | 11.60 | 52.0 | 150 |
| B | 203 | 11 | 180.05 | 5.60 | 11.62 | 65.1 | 150 |
| C | 159 | 9 | 180.05 | 4.46 | 11.57 | 51.6 | 150 |
| | 550 | ..... | ..... | ..... | ..... | 168.7 | ..... |

| Stick. | Loads applied. | | Compression. | Compression set. | Horizontal deflection. | Permanent horizontal deflection. |
|---|---|---|---|---|---|---|
| | Actual. | Pounds per sq. inch. | | | | |
| | *Pounds.* | | *Inch.* | *Inch.* | *Inch.* | *Inch.* |
| A | 26,000 | 500 | .0510 | .0096 | — .03 | 0. |
| B | 32,550 | 500 | .0660 | .0002 | — .10 | 0. |
| C | 25,800 | 500 | .0780 | .0015 | .26 | .04 |

*Test of the built post.*

| Loads applied. | Deflections. | | | Remarks. |
|---|---|---|---|---|
| | Horizontal. | Vertical, W. | Vertical, E. | |
| *Pounds.* | *Inch.* | *Inch.* | *Inch.* | |
| 0 | 0. | 0. | 0. | |
| 20,000 | .05 | .02 | 0. | |
| 40,000 | .05 | .04 | ..... | |
| 60,000 | .04 | .06 | ..... | Stick C has 20 knots in it from ¾" to 1¾" diameter. |
| 80,000 | .04 | .06 | ..... | |
| 100,000 | .03 | .06 | — .07 | |
| 140,000 | .03 | .07 | ..... | |
| 180,000 | .02 | .09 | ..... | |
| 200,000 | .01 | .10 | — .10 | |
| 220,000 | .01 | .11 | ..... | |
| 240,000 | 0. | .11 | ..... | |
| 260,000 | 0. | .11 | ..... | |
| 280,000 | — .01 | .12 | ..... | |
| 300,000 | .01 | .12 | —.13 | |
| 320,000 | — .04 | .14 | ..... | |
| 340,000 | — .14 | .15 | ..... | Ultimate strength = 2,015 pounds per square inch. |

Sustained maximum load 3 minutes, increasing horizontal deflection from — ".14 to — ".60.

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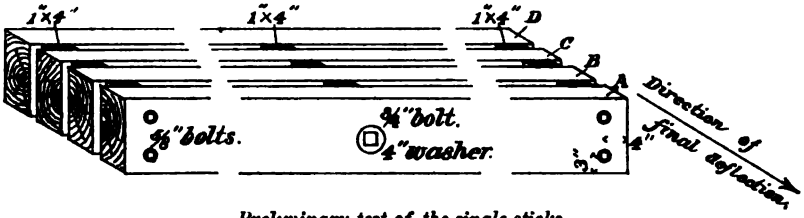
No. 681




*Preliminary test of the single sticks.*

| Stick. | Weight. | Rings per inch. | Total length. | Width. | Depth. | Sectional area. | Gauged length. |
|---|---|---|---|---|---|---|---|
| | *Pounds.* | | *Inches.* | *Inches.* | *Inches.* | *Sq. inches.* | *Inches.* |
| A | 193 | 5 | 179.95 | 4.47 | 11.60 | 51.9 | 150 |
| B | 192 | 5 | 179.95 | 4.52 | 11.65 | 52.7 | 150 |
| C | 146 | 9 | 179.95 | 4.48 | 11.65 | 52.2 | 150 |
| D | 157 | 9 | 179.95 | 4.51 | 11.65 | 52.5 | 150 |
| | 688 | | | | | 209.3 | |

| Stick. | Loads applied. | | Compression. | Compression set. | Horisontal deflection. | Permanent horizontal deflection. |
|---|---|---|---|---|---|---|
| | Actual. | Pounds per sq. inch. | | | | |
| | *Pounds.* | | *Inch.* | *Inch.* | *Inch.* | *Inch.* |
| A | 25,950 | 500 | .0700 | .0008 | —.04 | 0. |
| B | 26,350 | 500 | .0714 | .0003 | .06 | 0. |
| C | 26,100 | 500 | .0531 | .0004 | —.12 | 0. |
| D | 26,250 | 500 | .0762 | .0006 | 0. | .01 |

*Test of the built post.*

| Loads applied. | Loads per square inch. | Compression. | Compression set. | Deflections. | | | Remarks. |
|---|---|---|---|---|---|---|---|
| | | | | Horizontal. | Vertical, W. | Vertical, E. | |
| *Pounds.* | | *Inch.* | *Inch.* | *Inch.* | *Inch.* | *Inch.* | |
| 0 | 0 | 0. | 0. | 0. | 0. | 0. | Compression measured for 150″ on stick A. |
| 104,650 | 500 | .0575 | | | | | |
| 0 | 0 | | 0. | | | | |
| 20,000 | | | | 0. | .02 | | |
| 40,000 | | | | 0. | .05 | | |
| 60,000 | | | | 0. | .06 | | |
| 80,000 | | | | 0. | .07 | | |
| 100,000 | | | | 0. | .08 | —.07 | |
| 140,000 | | | | 0. | .09 | | |
| 180,000 | | | | —.01 | .10 | | |
| 200,000 | | | | —.02 | .10 | —.05 | |
| 240,000 | | | | —.05 | .10 | | |
| 280,000 | | | | —.08 | .10 | | |
| 300,000 | | | | —.10 | .11 | —.06 | |
| 340,000 | | | | —.18 | .12 | | |
| 350,000 | | | | —.26 | .12 | | |
| 360,000 | | | | —.38 | .13 | | |
| 363,000 | 1,734 | | | | | | Ultimate strength. |

Failed by horizontal deflection, minus direction; fibers of sticks B and C crushed at middle of post, at some knots.

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## No. 682.

Same style of post as No. 681.

*Preliminary test of the single sticks.*

| Stick. | Weight. | Rings per inch. | Total length. | Width. | Depth. | Sectional area. | Gauged length. |
|---|---|---|---|---|---|---|---|
| | *Pounds.* | | *Inches.* | *Inches.* | *Inches.* | *Sq. inches.* | *Inches.* |
| A | 161 | 7 | 180 | 4.50 | 11.63 | 52.3 | 150 |
| B | 156 | 14 | 180 | 4.50 | 11.64 | 52.4 | 150 |
| C | 163 | 7 | 180 | 4.49 | 11.60 | 52.1 | 150 |
| D | 151 | 9 | 180 | 4.50 | 11.63 | 52.3 | 150 |
| | 631 | ..... | ..... | ..... | ..... | 209.1 | ..... |

| Stick. | Loads applied. | | Compression. | Compression set. | Horizontal deflection. | Permanent horizontal deflection. |
|---|---|---|---|---|---|---|
| | Actual. | Pounds per sq. inch. | | | | |
| | *Pounds* | | *Inch.* | *Inch.* | *Inch.* | *Inch.* |
| A | 26,150 | 500 | .0612 | .0005 | 0. | 0. |
| B | 26,200 | 500 | .0546 | .0004 | —.06 | —.01 |
| C | 26,050 | 500 | .0542 | .0002 | 0. | 0. |
| D | 26,150 | 500 | .0916 | .0007 | 0. | 0. |

*Test of the built post.*

| Loads applied. | Deflections. | | | Remarks. |
|---|---|---|---|---|
| | Horizontal. | Vertical, W. | Vertical, E. | |
| *Pounds.* | *Inch.* | *Inch.* | *Inch.* | |
| 0 | 0. | 0. | 0. | |
| 20,000 | .02 | .03 | ..... | |
| 40,000 | .02 | .09 | —.09 | |
| 60,000 | .02 | .10 | ..... | |
| 80,000 | .02 | .10 | ..... | |
| 100,000 | .02 | .10 | ..... | |
| 140,000 | .01 | .10 | ..... | |
| 180,000 | 0. | .10 | ..... | |
| 200,000 | 0. | .10 | —.07 | |
| 240,000 | —.01 | .10 | ..... | |
| 280,000 | —.02 | .10 | ..... | |
| 300,000 | —.03 | .10 | —.04 | |
| 340,000 | —.07 | .09 | ..... | |
| 360,000 | —.11 | .07 | ..... | |
| 380,000 | —.17 | .10 | ..... | |
| 400,000 | —.26 | .08 | 0. | |
| 410,000 | —.50 | .10 | ..... | |
| 414,000 | —.70 | ..... | ..... | Ultimate strength = 1,980 pounds per square inch. |

**Post deflected horizontally, minus direction.**
**Stick D crushed at knots 24″ from middle.**

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## No. 683.

Same style of post as No. 681.

*Preliminary test of the single sticks.*

| Stick. | Weight. | Rings per inch. | Total length. | Width. | Depth. | Sectional area. | Gauged length. |
|---|---|---|---|---|---|---|---|
| | *Pounds.* | | *Inches.* | *Inches.* | *Inches.* | *Sq. inches.* | *Inches.* |
| A | 169 | 10 | 180.03 | 4.46 | 11.63 | 51.9 | 150 |
| B | 219 | 11 | 180.03 | 5.62 | 11.69 | 65.7 | 150 |
| C | 218 | 9 | 180.03 | 5.60 | 11.70 | 65.5 | 150 |
| D | 181 | 7 | 180.03 | 4.46 | 11.61 | 51.8 | 150 |
| | ..... | ..... | ..... | ..... | ..... | 234.9 | ..... |

| Stick. | Loads applied. | | Compression. | Compression set. | Horizontal deflection. | Permanent horizontal deflection. |
|---|---|---|---|---|---|---|
| | Actual. | Pounds per sq. inch. | | | | |
| | *Pounds.* | | *Inch.* | *Inch.* | *Inch.* | *Inch.* |
| A | 26,950 | 500 | .0570 | 0. | .01 | 0. |
| B | 32,850 | 500 | .0530 | .0002 | 0. | 0. |
| C | 32,750 | 500 | .0494 | .0008 | .04 | 0. |
| D | 25,900 | 500 | .0590 | 0. | — .04 | 0. |

*Test of the built post.*

| Loads applied. | Deflections. | | | Remarks. |
|---|---|---|---|---|
| | Horizontal. | Vertical, W. | Vertical, E. | |
| *Pounds.* | *Inch.* | *Inch.* | *Inch.* | |
| 0 | 0. | 0. | 0. | |
| 20,000 | 0. | 0. | ..... | |
| 40,000 | 0. | 0. | ..... | |
| 60,000 | 0. | 0. | ..... | |
| 80,000 | 0. | 0. | ..... | |
| 100,000 | 0. | .01 | 0. | |
| 140,000 | 0. | .02 | ..... | |
| 180,000 | 0. | .02 | ..... | |
| 200,000 | 0. | .02 | .04 | |
| 240,000 | 0. | .02 | ..... | |
| 280,000 | 0. | .02 | ..... | |
| 300,000 | — .01 | .02 | ..... | |
| 340,000 | — .01 | .02 | ..... | |
| 380,000 | — .01 | .02 | ..... | |
| 400,000 | — .01 | .02 | ..... | |
| 420,000 | 0. | .02 | ..... | |
| 440,000 | 0. | .02 | ..... | |
| 460,000 | .01 | .02 | ..... | |
| 480,000 | .04 | .02 | ..... | |
| 500,000 | .13 | .02 | .13 | |
| 501,000 | ..... | ..... | ..... | Ultimate strength = 2,133 pounds per square inch. |

Stick A crushed 24″ from middle.
Stick B crushed 26″ from middle.
Stick C crushed 8″ from middle.
All failures occurring in the vicinity of knots.

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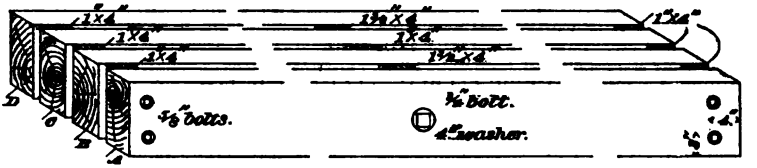
## No. 684.

## SWELLED POST.




*Preliminary test of the single sticks.*

| Stick. | Weight. | Rings per inch. | Total length. | Width. | Depth. | Sectional area. | Gauged length. |
|---|---|---|---|---|---|---|---|
| | *Pounds.* | | *Inches.* | *Inches.* | *Inches.* | *Sq. inches.* | *Inches.* |
| A | 146 | 10 | 180 | 4.50 | 11.64 | 52.4 | 150 |
| B | 210 | 12 | 180 | 5.64 | 11.59 | 65.4 | 150 |
| C | 284 | 7 | 180 | 5.60 | 11.58 | 64.8 | 150 |
| D | 166 | 10 | 180 | 4.48 | 11.61 | 52.0 | 150 |
| | 756 | ..... | ..... | ..... | ..... | 234.6 | ..... |

| Stick. | Loads applied. | | Compression. | Compression set. | Horizontal deflection. | Permanent horizontal deflection. |
|---|---|---|---|---|---|---|
| | Actual. | Pounds per square inch. | | | | |
| | *Pounds.* | | *Inch.* | *Inch.* | *Inch.* | *Inch.* |
| A | 26,200 | 500 | .0664 | .0006 | —.18 | 0. |
| B | 33,700 | 500 | .0610 | .0004 | .03 | 0. |
| C | 32,400 | 500 | .0648 | 0. | 0. | .01 |
| D | 26,000 | 500 | .0514 | .0002 | .32 | .01 |

*Test of the built post.*

| Loads applied. | Deflections. | | | Remarks. |
|---|---|---|---|---|
| | Horizontal. | Vertical, W. | Vertical, E. | |
| *Pounds.* | *Inch.* | *Inch.* | *Inch.* | |
| 0 | 0. | 0. | 0. | |
| 20,000 | 0. | .01 | ..... | |
| 40,000 | 0. | 0. | ..... | |
| 60,000 | 0. | 0. | ..... | |
| 80,000 | 0. | —.01 | ..... | |
| 100,000 | 0. | —.02 | .02 | |
| 140,000 | 0. | —.04 | ..... | |
| 180,000 | 0. | —.04 | ..... | |
| 200,000 | 0. | —.04 | .05 | |
| 240,000 | 0. | —.04 | ..... | |
| 280,000 | 0. | —.05 | ..... | |
| 300,000 | 0. | —.05 | .09 | |
| 340,000 | 0. | —.05 | ..... | |
| 380,000 | 0. | —.05 | ..... | |
| 400,000 | 0. | —.06 | .12 | |
| 430,000 | .01 | —.06 | ..... | |
| 440,000 | .03 | —.06 | ..... | |
| 450,000 | .03 | —.07 | ..... | |
| 460,000 | .04 | —.07 | ..... | |
| 470,000 | .06 | —.08 | ..... | |
| 480,000 | .08 | —.08 | ..... | |
| 490,000 | .10 | —.08 | ..... | |
| 500,000 | .10 | —.08 | ..... | |
| 510,000 | .15 | —.08 | ..... | |
| 520,000 | .20 | —.08 | ..... | |
| 529,000 | .45 | —.08 | ..... | Ultimate strength = 2,255 pounds per square inch. |

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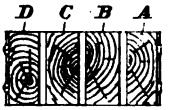
Stick A, fibers crushed at middle.
Stick B, fibers crushed 32″ from middle.
Stick C, fibers crushed 8″ from middle of post.

## No. 685.

Same style of post as No. 684.




*End spaces 1″ each.*
*inside middle space 1″,*
*outside „ spaces 1⅛″ each.*

*Preliminary test of the single sticks.*

| Stick. | Weight. | Rings per inch. | Total length. | Width. | Depth. | Sectional area. | Gauged length. |
|---|---|---|---|---|---|---|---|
| | *Pounds.* | | *Inches.* | *Inches.* | *Inches.* | *Sq. inches.* | *Inches.* |
| A | 145 | 10 | 180 | 4.50 | 11.60 | 52.2 | 150 |
| B | 220 | 10 | 180 | 5.63 | 11.62 | 65.4 | 150 |
| C | 209 | 12 | 180 | 5.61 | 11.62 | 65.2 | 150 |
| D | 166 | 9 | 180 | 4.48 | 11.62 | 52.0 | 150 |
| | 740 | ..... | ..... | ..... | ..... | 234.8 | ..... |

| Stick. | Loads applied. | | Compression. | Compression set. | Horizontal deflection. | Permanent horizontal deflection. |
|---|---|---|---|---|---|---|
| | Actual. | Pounds per square inch. | | | | |
| | *Pounds.* | | *Inch.* | *Inch.* | *Inch.* | *Inch.* |
| A | 26,100 | 500 | .0645 | .0005 | — .30 | 0. |
| B | 32,700 | 500 | .0650 | .0002 | .07 | .01 |
| C | 32,600 | 500 | .0506 | .0004 | .05 | 0. |
| D | 26,000 | 500 | .0546 | .0005 | .35 | .02 |

*Test of the built post.*

| Loads applied. | Deflections. | | | Remarks. |
|---|---|---|---|---|
| | Horizontal. | Vertical, W. | Vertical, E | |
| *Pounds.* | *Inch.* | *Inch.* | *Inch.* | |
| 0 | 0. | 0. | 0. | |
| 20,000 | .02 | .03 | .02 | |
| 40,000 | .03 | .05 | ..... | |
| 60,000 | .03 | .05 | ..... | |
| 80,000 | .03 | .05 | ..... | |
| 100,000 | .03 | .05 | ..... | |
| 140,000 | .04 | .05 | ..... | |
| 180,000 | .05 | .05 | ..... | |
| 200,000 | .05 | .05 | .11 | |
| 240,000 | .07 | .05 | ..... | |
| 280,000 | .09 | .05 | ..... | |
| 300,000 | .10 | .05 | .11 | |
| 340,000 | .12 | .05 | ..... | |
| 380,000 | .15 | .05 | ..... | |
| 400,000 | .17 | .05 | ..... | |
| 420,000 | .13 | .05 | ..... | |
| 430,000 | .04 | .05 | ..... | Ultimate strength = 1,831 pounds per square inch. |

Sticks A and C failed at some knots 42″ from the north end of the pots.

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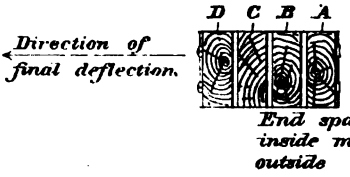
## No. 686.

### Same style of post as No. 684.




*End spaces 1" each,*
*inside middle space 1",*
*outside " spaces 1¾" each.*

*Preliminary test of the single sticks.*

| Stick. | Weight. | Rings per inch. | Total length. | Width. | Depth. | Sectional area. | Ganged length. |
|---|---|---|---|---|---|---|---|
| | *Pounds.* | | *Inches.* | *Inches.* | *Inches.* | *Sq. inches.* | *Inches.* |
| A | 145 | 11 | 180 | 4.48 | 11.61 | 52.0 | 150 |
| B | 183 | 10 | 180 | 4.50 | 11.56 | 52.0 | 150 |
| C | 159 | 12 | 180 | 4.50 | 11.36 | 51.1 | 150 |
| D | 150 | 8 | 180 | 4.52 | 11.61 | 52.5 | 150 |
| | 637 | ..... | ..... | ..... | ..... | 207.6 | ..... |

| Stick. | Loads applied. Actual. | Loads applied. Pounds per square inch. | Compression. | Compression set. | Horizontal deflection. | Permanent horizontal deflection. |
|---|---|---|---|---|---|---|
| | *Pounds.* | | *Inch.* | *Inch.* | *Inch.* | *Inch.* |
| A | 26,000 | 500 | .0500 | .0002 | —.25 | —.02 |
| B | 26,000 | 500 | .0315 | 0. | .07 | .01 |
| C | 25,550 | 500 | .0543 | .0002 | .02 | .01 |
| D | 26,250 | 500 | .0680 | .0005 | .05 | .01 |

*Test of the built post.*

| Loads applied. | Deflections. Horizontal. | Vertical, W. | Vertical, E. | Remarks. |
|---|---|---|---|---|
| *Pounds.* | *Inch.* | *Inch.* | *Inch.* | |
| 0 | 0. | 0. | 0. | |
| 20,000 | 0. | .05 | 0. | Stick A has very poor appearance. Dead wood along the corner about 3 square inches area. |
| 40,000 | 0. | .10 | ..... | |
| 60,000 | 0. | .13 | ..... | |
| 80,000 | 0. | .14 | ..... | |
| 100,000 | .01 | .15 | 0. | |
| 120,000 | .01 | .14 | ..... | |
| 140,000 | .02 | .14 | ..... | |
| 160,000 | .02 | .14 | ..... | |
| 180,000 | .02 | .14 | ..... | |
| 200,000 | .03 | .14 | ..... | |
| 220,000 | .04 | .14 | ..... | |
| 240,000 | .04 | .14 | .01 | |
| 260,000 | .04 | .14 | ..... | |
| 280,000 | .05 | .14 | ..... | |
| 300,000 | .06 | .13 | ..... | |
| 320,000 | .07 | .13 | ..... | |
| 340,000 | .09 | .12 | ..... | |
| 360,000 | .11 | .11 | .04 | |
| 388,000 | .17 | .11 | ..... | |
| 395,000 | Ab't. 30 | ..... | ..... | Ultimate strength = 1,903 pounds per square inch. |

Failed by horizontal deflection in plus direction. Horizontal deflection increased rapidly when the ultimate load was reached. Fibers of stick A crushed at the ¾" bolt-hole, and in vicinity of two knots ¾" diameter at middle, a sharp bend occurring at this point.



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## COMPRESSION OF WHITE PINE POSTS.

### TABULATED RESULTS.

| Number of test. | Weight. | Average rate of growth. | Size of post. | | | Sectional area. | Ultimate strength. | | Manner of failure. |
|---|---|---|---|---|---|---|---|---|---|
| | | | Length. | Width. | Depth. | | Actual. | Pounds per square inch. | |
| | *Pounds.* | *Rings per inch.* | *Ft. In.* | *Inches.* | *Inches.* | *Square inches.* | *Pounds.* | | |
| 511 | 7 | | 15 | 5.50 | 5.50 | 30.25 | 108,000 | 3,570 | Fibers crushed. |
| 491 | 26½ | | 4 11.95 | 5 48 | 5.48 | 30 | 111,000 | 3,700 | Failed at a knot 14″ from end of post. |
| 492 | 31 | | 5 .05 | 5.48 | 5.48 | 30 | 99,300 | 3,100 | Failed at a knot 15″ from end of post. |
| 493 | 43½ | | 7 6.10 | 5.50 | 5.52 | 30.4 | 67,400 | 2,217 | Failed at knots 28″ from end of post. |
| 494 | 37½ | | 7 6.10 | 5.47 | 5.47 | 29.9 | 70,800 | 2,368 | Failed at knots 16″ from end of post. |
| 495 | 45 | | 7 6.10 | 5.50 | 5.45 | 29.8 | 74,100 | 2,487 | Failed at knots 20″ and 25″ from end of post. |
| 512 | 62½ | | 10 .10 | 5.48 | 5.49 | 30.1 | 82,000 | 2,724 | Failed at knots 40″ from end of post. |
| 519 | 49½ | | 10 .10 | 5.48 | 5.42 | 29.7 | 75,400 | 2,539 | Failed at knots near middle of post. |
| 520 | 59½ | | 10 .10 | 5.45 | 5.45 | 29.7 | 61,700 | 2,077 | Failed at knots 30″ from end of post. |
| 516 | 60 | | 12 6.15 | 5.46 | 5.46 | 29.8 | 68,000 | 2,282 | Failed at knots 64″ from end of post. |
| 517 | 70 | | 12 6.16 | 5.50 | 5.50 | 30.25 | 70,800 | 2,340 | Failed at knots 58″ from end of post. |
| 518 | 67½ | | 12 6.10 | 5.48 | 5.52 | 30.25 | 100,000 | 3,306 | Failed at knots 31″ from end of post. |
| 513 | 84½ | | 15 .27 | 5.47 | 5.47 | 29.9 | 54,000 | 1,806 | Failed at knots 66″ from end of post. |
| 514 | 90 | | 15 .31 | 5.48 | 5.48 | 30 | 93,500 | 3,117 | Deflected diagonally and failed at knots. |
| 515 | 91 | | 15 .28 | 5.33 | 5.33 | 28.4 | 94,000 | 3,310 | Do. |
| 521 | 96½ | | 17 6.24 | 5.35 | 5.35 | 28.6 | 53,000 | 1,853 | Do. |
| 522 | 101 | | 17 6.25 | 5.40 | 5.38 | 29 | 40,500 | 1,396 | Deflected downward; wind-shake on concave side. |
| 523 | 95 | | 17 6.22 | 5.33 | 5.35 | 28.5 | 64,800 | 2,274 | Deflected horizontally. |
| 524 | 109½ | | 20 .25 | 5.28 | 5.26 | 27.8 | 45,000 | 1,619 | Deflected diagonally. |
| 525 | 106½ | | 20 .27 | 5.29 | 5.27 | 27.9 | 39,500 | 1,416 | Do. |
| 526 | 95 | | 20 .28 | 5.25 | 5.29 | 27.8 | 37,000 | 1,331 | Deflected horizontally. |
| 505 | 110 | | 22 6.26 | 5.16 | 5.18 | 26.7 | 37,000 | 1,386 | Do. |
| 506 | 113 | | 22 6.23 | 5.20 | 5 22 | 27.1 | 37,200 | 1,373 | Do. |
| 507 | 118 | | 22 6.26 | 5.18 | 5.18 | 26.8 | 46,700 | 1,743 | Do. |
| 502 | 127 | | 25 .31 | 5.27 | 5.25 | 27.7 | 30,900 | 1,116 | Deflected diagonally. |
| 503 | 125 | | 25 .34 | 5.25 | 5.25 | 27.6 | 25,800 | 935 | Deflected sideways. |
| 504 | 127 | | 25 .37 | 5.25 | 5.25 | 27.6 | 22,200 | 804 | Deflected diagonally. |
| 496 | 169 | | 27 6.35 | 5.32 | 5.34 | 28.4 | 32,500 | 1,144 | Do. |
| 497 | 173 | | 27 6.40 | 5.35 | 5.35 | 28.6 | 32,000 | 1,119 | Do. |
| 498 | 157 | | 27 6.30 | 5.35 | 5.35 | 28.6 | 28,000 | 979 | Do. |
| 569 | 94 | | 6 8.07 | 7.77 | 9.64 | 74.9 | 204,000 | 2,724 | Failed at knots 10″ from middle of post. |
| 570 | 93 | 7 | 6 8.10 | 7.70 | 9.70 | 74.7 | 177,000 | 2,369 | Failed at knots near middle of post. |
| 571 | 120½ | 12 | 6 8.13 | 7.73 | 9.63 | 74.4 | 185,000 | 2,487 | Failed at knots 9″ from end of post. |
| 575 | 166 | 15 | 10 .13 | 7.75 | 9.62 | 74.6 | 186,000 | 2,493 | Failed at knots 21″ from end of post. |

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| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| 576 | 166 | 11 | 10 | .18 | 7.72 | 9.76 | 75.3 | 204,600 | 2,717 | Failed at knots 13″ and 27″ from end of post. |
| 577 | 160 | 10 | 10 | .13 | 7.73 | 9.74 | 75.3 | 185,000 | 1,793 | Failed at knots 8″ and 11″ from end of post. |
| 581 | 221 | 7 | 13 | 4.12 | 7.75 | 9.75 | 75.6 | 168,000 | 2,222 | Failed at knots 14″ and 44″ from end of post. |
| 582 | 182 | 3 | 13 | 4.14 | 7.75 | 9.75 | 75.6 | 127,500 | 1,687 | Failed at knots 18″ and 18″ from end of post. |
| 583 | 1964 | 13 | 13 | 4.14 | 7.48 | 9.23 | 69.0 | 208,500 | 3,022 | Failed at knots 50″ from end of post. |
| 590 | 242 | 7 | 16 | 8.20 | 7.72 | 9.63 | 74.3 | 151,000 | 2,167 | Failed at knots 20″ from end of post. |
| 591 | 2104 | 9 | 16 | 8.22 | 7.78 | 9.58 | 74.5 | 163,000 | 2,188 | Failed at knots near middle of post. |
| 592 | 274 | 8 | 16 | 8.21 | 7.75 | 9.75 | 75.6 | 175,300 | 2,319 | Failed at knots 75″ from end of post. |
| 533 | 278 | | 20 | .24 | 7.59 | 9.62 | 73.0 | 140,000 | 1,918 | Deflected horizontally. |
| 534 | 285 | | 20 | .26 | 7.38 | 9.29 | 68.6 | 166,000 | 2,420 | Failed at knot near middle of post. |
| 535 | 295 | | 20 | .25 | 7.39 | 9.27 | 68.5 | 206,000 | 3,007 | Failed at knot 24″ from middle of post. |
| 539 | 352 | | 23 | 4.20 | 7.73 | 9.75 | 75.4 | 140,000 | 1,857 | Deflected horizontally. |
| 540 | 357 | | 23 | 4.20 | 7.72 | 9.61 | 74.2 | 170,000 | 2,291 | Do. |
| 541 | 340 | | 23 | 4.18 | 7.68 | 9.50 | 72.5 | 150,000 | 2,069 | Deflected diagonally. |
| 536 | 427 | | 26 | 8.20 | 7.46 | 9.36 | 69.8 | 160,000 | 2,421 | Deflected horizontally. |
| 537 | 397 | | 26 | 8.39 | 7.49 | 9.34 | 70.0 | 140,000 | 2,000 | Do. |
| 538 | 384 | | 26 | 8.27 | 7.46 | 9.37 | 69.9 | 134,000 | 1,917 | Deflected horizontally; knots on concave side. |
| 702 | 300 | 10 | 15 | .02 | 5.60 | 15.58 | 87.2 | 159,000 | 1,823 | Failed at knots 29″ from end of post. |
| 703 | 267 | 5 | 15 | .08 | 5.61 | 15.60 | 87.5 | 168,500 | 1,926 | Deflected horizontally. |
| 704 | 267 | 12 | 15 | .00 | 5.65 | 15.60 | 88.1 | 165,000 | 1,873 | Do. |
| 699 | 356 | 7 | 15 | .00 | 6.60 | 15.64 | 103.2 | 240,000 | 2,326 | Failed at knots 40″ from end of post. |
| 700 | 395 | 10 | 14 | 11.94 | 6.60 | 15.64 | 103.2 | 239,000 | 2,316 | Failed at knots 10″ and 60″ from end of post. |
| 701 | 376 | 7 | 15 | .00 | 6.60 | 15.60 | 103 | 203,700 | 1,971 | Failed at knots 15″ from middle of post. |
| 705 | 657 | 6 | 15 | .03 | 8.47 | 16.43 | 139.2 | 279,440 | 2,007 | Failed at knots at middle of stick. |
| 706 | 437 | 5 | 15 | .00 | 8.48 | 16.46 | 139.6 | 292,000 | 2,092 | Do. |
| 707 | 447 | 5 | 14 | 11.93 | 8.48 | 16.48 | 139.8 | 359,000 | 2,568 | Deflected horizontally; fibers crushed near end of post. |

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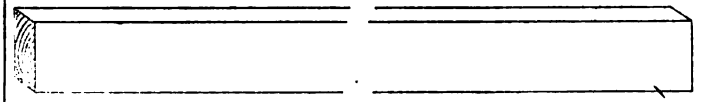
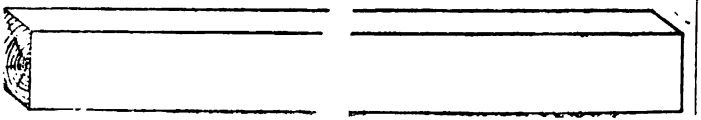
## COMPRESSION OF WHITE PINE.

### *Single sticks and built posts.*

TABULATED RESULTS.

| Number of test. | Kind of post. | Weight. | Average rate of growth. Rings per inch. | Dimensions of post. | | | Sectional area. | Compression in 150 inches. Load of 500 pounds per square inch. | Ultimate strength. | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Length. | Width. | Depth. | | | Actual. | Pounds per square inch. |
| | | *Pounds.* | | *Inches.* | *Inches.* | *Inches.* | *Sq. inches.* | *Inch.* | *Pounds.* | |
| 664 |  | 153 | 11 | 177.50 | 4.48 | 11.65 | 52.2 | .0545 | 110,000 | 2,107 |
| 665 | | 143 | 10 | 180 | 4.48 | 11.64 | 52.1 | .1010 | 81,500 | 1,564 |
| 666 | | 163 | 5 | 179.97 | 4.47 | 11.63 | 52.0 | .0895 | 70,000 | 1,346 |
| 667 |  | 228 | 13 | 180 | 5.40 | 11.30 | 61.0 | .0505 | 160,000 | 2,623 |

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| | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 668 | | 193 | 5 | 179.63 | 5.61 | 11.73 | 65.8 | .0622 | 156,300 | 2,375 |
| 669 | | 258 | 5 | 180 | 5.64 | 11.76 | 66.3 | .0608 | 152,800 | 2,297 |
| 638 | | 181<br>134 | 6<br>8 | 180<br>180 | 4.50<br>4.50 | 11.60<br>11.59 | 52.2<br>52.2 | 104.4 | .0670<br>.0750 | 200,000 | 1,916 |
| 639 | Same style as No. 638 | 183<br>167 | 7<br>5 | 180<br>180 | 4.52<br>4.49 | 11.66<br>11.62 | 52.7<br>52.2 | 104.9 | .0645<br>.0670 | 212,000 | 2,021 |
| 640 | Same style as No. 638 | 131<br>158 | 7<br>5 | 180<br>180 | 4.53<br>4.52 | 11.59<br>11.59 | 52.5<br>52.5 | 105.0 | .1060<br>.0855 | 149,000 | 1,419 |
| 642 | | 192<br>306 | 6<br>7 | 179.98<br>179.98 | 5.57<br>5.58 | 11.61<br>11.61 | 64.7<br>64.7 | 129.4 | .0770<br>.0390 | 215,000 | 1,661 |
| 643 | Same style as No. 642 | 203<br>189 | 17<br>5 | 179.92<br>179.92 | 5.65<br>5.61 | 11.61<br>11.62 | 65.6<br>65.2 | 130.8 | .0440<br>.0600 | 261,000 | 1,995 |
| 644 | Same style as No. 642 | 227<br>236 | 7<br>7 | 179.96<br>179.96 | 5.60<br>5.60 | 11.63<br>11.62 | 65.1<br>65.1½ | 130.2 | .0596<br>.0690 | 257,800 | 1,980 |

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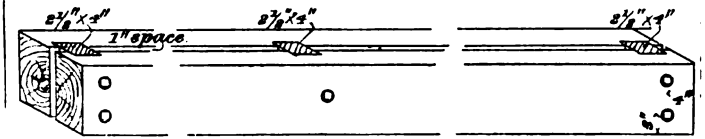
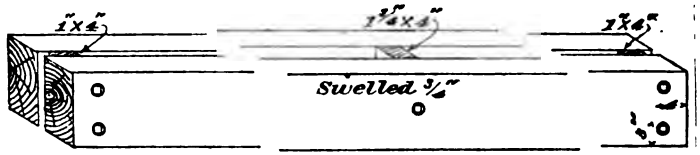
## COMPRESSION OF WHITE PINE—Continued.

| Number of test. | Kind of post. | Weight. | Average rate of growth. Rings per inch. | Dimensions of post. Length. | Width. | Depth. | Sectional area. | Compression in 150 inches. Load of 500 pounds per square inch. | Ultimate strength. Actual. | Pounds per square inch. |
|---|---|---|---|---|---|---|---|---|---|---|
| | | *Pounds.* | | *Inches.* | *Inches.* | *Inches.* | *Sq. inches.* | *Inch.* | *Pounds.* | |
| 648 | | 206 } 409<br>203 } | 12<br>10 | 180<br>180 | 5.60<br>5.61 | 11.72<br>11.72 | 65.6 } 131.2<br>65.6 } | .0590<br>.0700 | 268,000 | 2,042 |
| 649 | Same style as No. 648 | 187 } 371<br>184 } | 9<br>4 | 180<br>180 | 5.60<br>5.61 | 11.71<br>11.74 | 65.6 } 131.5<br>65.9 } | .0600<br>.0705 | 277,000 | 2,107 |
| 650 | Same style as No. 648 | 194 } 384<br>190 } | 12<br>9 | 180<br>180 | 5.61<br>5.61 | 11.75<br>11.71 | 65.9 } 131.6<br>65.7 } | .0530<br>.0885 | 240,000 | 1,824 |
| 645 |  | 215 } 481<br>266 } | 5<br>7 | 179.97<br>179.97 | 5.59<br>5.60 | 11.59<br>11.60 | 64.8 } 129.8<br>65.0 } | .0560<br>.0540 | 263,200 | 2,028 |
| 646 | Same style as No. 645 | 206 } 410<br>204 } | 6<br>12 | 180<br>180 | 5.59<br>5.60 | 11.61<br>11.62 | 64.9 } 130.0<br>65.1 } | .0493<br>.0620 | 249,000 | 1,915 |
| 647 | Same style as No. 645 | 192 } 384<br>192 } | 11<br>13 | 180<br>180 | 5.62<br>5.62 | 11.62<br>11.62 | 65.3 } 130.6<br>65.3 } | .0630<br>.0700 | 248,000 | 1,899 |

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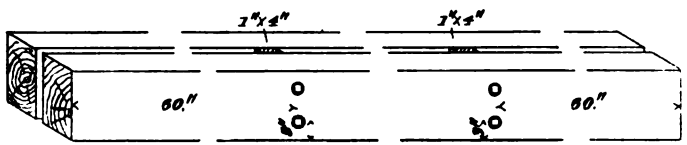
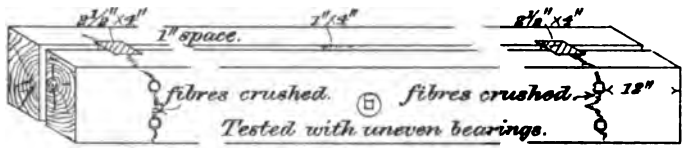
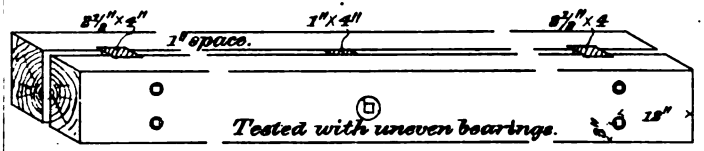
| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 678 |  | 251<br>215 | 466 | 16<br>8 | 179.94<br>179.94 | 5.58<br>5.57 | 11.47<br>11.45 | 64.0<br>63.8 | 127.8 | .0529<br>.0642 | 245,500 | 1,921 |
| 679 | Same style as No. 678 | 209<br>190 | 399 | 12<br>7 | 180<br>180 | 5.62<br>5.62 | 11.76<br>11.72 | 66.1<br>65.9 | 132.0 | .0664<br>.0705 | 249,000 | 1,886 |
| 680 | Same style as No. 678 | 268<br>278 | 546 | 8<br>8 | 180<br>180 | 5.60<br>5.61 | 11.72<br>11.73 | 65.6<br>65.8 | 131.4 | .0650<br>.0495 | 278,000 | 2,116 |
| 663 |  | 230<br>208 | 438 | 14<br>6 | 180<br>180 | 5.60<br>5.63 | 11.75<br>11.75 | 65.8<br>66.2 | 132.0 | .0621<br>.0657 | 300,000 | 2,273 |
| 676 |  | 201<br>184 | 385 | 12<br>6 | 179.94<br>179.94 | 5.60<br>5.61 | 11.71<br>11.73 | 65.6<br>65.8 | 131.4 | .0530<br>.0593 | 274,500 | 2,089 |
| 677 | Same style of post as No. 676. Tested with uneven bearings | 185<br>193 | 378 | 6<br>6 | 180<br>180 | 5.61<br>5.58 | 11.72<br>11.72 | 65.7<br>65.4 | 131.1 | .0551<br>.0625 | 255,000 | 1,945 |
| 690 | | 175<br>226<br>199 | 600 | 18<br>11<br>18 | 180<br>180<br>180 | 4.52<br>5.56<br>4.46 | 11.62<br>11.70<br>11.62 | 52.5<br>65.0<br>51.8 | 169.3 | .0460<br>.0580<br>.0480 | 310,000 | 1,831 |
| 691 | Same style as No. 690 | 164<br>197<br>159 | 520 | 9<br>14<br>12 | 179.98<br>179.98<br>179.98 | 4.48<br>5.56<br>4.45 | 11.60<br>11.60<br>11.61 | 52.0<br>64.5<br>51.7 | 168.2 | .0526<br>.0430<br>.0390 | 372,500 | 2,215 |

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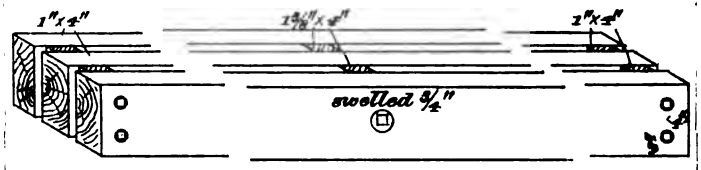
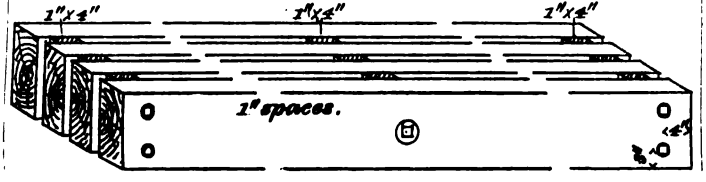
## COMPRESSION OF WHITE PINE—Continued.

| Number of test. | Kind of post. | Weight. | Average rate of growth. Rings per inch. | Dimensions of post. Length. | Width. | Depth. | Sectional area. | Compression in 150 inches. Load of 500 pounds per square inch. | Ultimate strength. Actual. | Pounds per square inch. |
|---|---|---|---|---|---|---|---|---|---|---|
| | | *Pounds.* | | *Inches.* | *Inches.* | *Inches.* | *Sq. inches.* | *Inch.* | *Pounds.* | |
| 692 | Same style as No. 690 | 248<br>153 } 614<br>213 | 13<br>12<br>5 | 177.25<br>177.25<br>177.25 | 5.62<br>4.50<br>5.60 | 11.60<br>11.60<br>11.57 | 65.2<br>52.2 } 182.2<br>64.8 | .0580<br>.0641<br>.0768 | 363,000 | 1,992 |
| 687 |  | 151<br>218 } 536<br>167 | 11<br>8<br>9 | 180<br>180<br>180 | 4.50<br>5.58<br>4.52 | 11.60<br>11.62<br>11.59 | 52.2<br>64.8 } 169.4<br>52.4 | .0460<br>.0587<br>.0533 | 325,590 | 1,919 |
| 688 | Same style as No. 687 | 176<br>236 } 575<br>163 | 10<br>10<br>11 | 180<br>180<br>180 | 4.50<br>5.62<br>4.50 | 11.60<br>11.60<br>11.60 | 52.2<br>65.2 } 169.6<br>52.2 | .0565<br>.0645<br>.0703 | 306,000 | 1,804 |
| 689 | Same style as No. 687 | 188<br>203 } 550<br>159 | 7<br>11<br>9 | 180.05<br>180.05<br>180.05 | 4.48<br>5.60<br>4.46 | 11.60<br>11.62<br>11.57 | 52.0<br>65.1 } 168.7<br>51.6 | .0510<br>.0660<br>.0789 | 340,000 | 2,015 |
| 681 |  | 193<br>192<br>146<br>157 } 688 | 5<br>5<br>9<br>9 | 179.95<br>179.95<br>179.95<br>179.95 | 4.47<br>4.52<br>4.48<br>4.51 | 11.60<br>11.65<br>11.65<br>11.65 | 51.9<br>52.7<br>52.2<br>52.5 } 209.3 | .0700<br>.0714<br>.0531<br>.0762 | 363,000 | 1,734 |

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| | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 682 | Same style as No. 681 | 161<br>156<br>163<br>151 | 631 | 7<br>14<br>7<br>9 | 180<br>180<br>180<br>180 | 4.50<br>4.50<br>4.49<br>4.50 | 11.68<br>11.64<br>11.60<br>11.63 | 52.3<br>52.4<br>52.1<br>52.3 | 209.1 | .0612<br>.0546<br>.0542<br>.0916 | 414,000 | 1,930 |
| 683 | Same style as No. 681 | 169<br>219<br>218<br>181 | 787 | 10<br>11<br>9<br>7 | 180.03<br>180.03<br>180.03<br>180.03 | 4.46<br>5.62<br>5.60<br>4.46 | 11.63<br>11.60<br>11.70<br>11.61 | 51.9<br>65.7<br>65.5<br>51.8 | 234.9 | .0570<br>.0530<br>.0494<br>.0560 | 501,000 | 2,133 |
| 684 | | 146<br>210<br>234<br>166 | 756 | 10<br>12<br>7<br>10 | 180<br>180<br>180<br>180 | 4.50<br>5.64<br>5.60<br>4.48 | 11.64<br>11.59<br>11.58<br>11.61 | 52.4<br>65.4<br>64.8<br>52.0 | 234.6 | .0664<br>.0610<br>.0548<br>.0514 | 529,000 | 2,255 |
| 685 | Same style as No. 684 | 145<br>220<br>209<br>166 | 740 | 10<br>10<br>12<br>9 | 190<br>180<br>180<br>180 | 4.50<br>5.63<br>5.61<br>4.48 | 11.60<br>11.62<br>11.62<br>11.62 | 52.2<br>65.4<br>65.2<br>52.0 | 234.8 | .0645<br>.0650<br>.0506<br>.0546 | 430,000 | 1,831 |
| 686 | Same style as No. 684 | 145<br>138<br>159<br>150 | 687 | 11<br>10<br>12<br>8 | 180<br>180<br>180<br>180 | 4.48<br>4.50<br>4.50<br>4.63 | 11.61<br>11.56<br>11.36<br>11.61 | 52.0<br>52.0<br>51.1<br>52.5 | 207.6 | .0500<br>.0315<br>.0543<br>.0680 | 396,000 | 1,903 |




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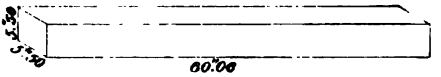
## COMPRESSION TESTS OF YELLOW-PINE POSTS.

### No. 565.

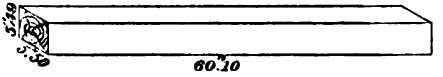



Average growth, 20 rings per inch.
Sectional area, 3.03 square inches.
Gauged length, 50″.
Weight, 47 pounds.
Not counterweighted.
Post free from knots.

| Loads applied. | Pounds per square inch. | Compression. | Permanent set. | Remarks. |
|---|---|---|---|---|
| *Pounds.* | | *Inch.* | *Inch.* | |
| 3,030 | 100 | 0. | | |
| 15,150 | 500 | .0108 | | |
| | 100 | | 0. | |
| 30,300 | 1,000 | .0225 | | |
| | 100 | | .0005 | |
| 45,450 | 1,500 | .0350 | | |
| | 100 | | .0010 | |
| 60,600 | 2,000 | .0485 | | |
| | 100 | | .0020 | |
| 172,000 | 5,677 | | | Ultimate strength. |

Crushed fibers 12″ from end.

### No. 566.




Average growth, 12 rings per inch.
Sectional area, 30.2 square inches.
Gauged length, 50″.
Weight, 44 pounds.
Not counterweighted.

| Loads applied. | Pounds per square inch. | Compression. | Permanent set. | Remarks. |
|---|---|---|---|---|
| *Pounds.* | | *Inch.* | *Inch.* | |
| 3,020 | 100 | 0. | | |
| 15,100 | 500 | .0126 | | |
| | 100 | | .0002 | |
| 30,200 | 1,000 | .0247 | | |
| | 100 | | .0002 | |
| 45,300 | 1,500 | .0430 | | |
| | 100 | | .0007 | |
| 60,400 | 2,000 | .0590 | | |
| | 100 | | .0010 | |
| 141,000 | 4,669 | | | Ultimate strength. |

Failed at knots 15″ from end.

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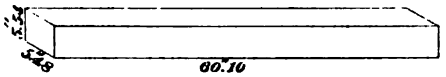
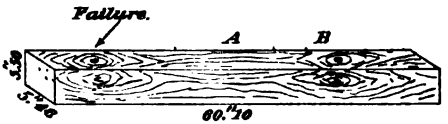
No. 567.




Sectional area, 30.4 square inches.
Gauged length, 50″.
Weight, 45 pounds.
Not counterweighted.
Average growth, 25 rings per inch.

| Loads applied. | Pounds per square inch. | Compression. | Permanent set. | Remarks. |
|---|---|---|---|---|
| *Pounds.* | | *Inch.* | *Inch.* | |
| 3,040 | 100 | 0. | ..... | |
| 15,200 | 500 | .0080 | ..... | |
| ..... | 100 | ..... | 0. | |
| 30,400 | 1,000 | .0200 | ..... | |
| ..... | 100 | ..... | 0. | |
| 45,600 | 1,500 | .0318 | ..... | |
| ..... | 100 | ..... | 0. | |
| 60,800 | 2,000 | .0441 | ..... | |
| ..... | 100 | ..... | .0005 | |
| 168,000 | 5,526 | ..... | ..... | Ultimate strength. |

Failed at knots at 9″ and 17″ from end.




No. 568.

Sectional area, 30 square inches.
Weight, 47½ pounds.
Not counterweighted.
Post has a large knot near each end, straight-grain section between the knots.
Two gauged lengths.
Gauged length A, 15″ on straight-grain section.
Gauged length B, 10″ on section containing knot.
Average growth, 20 rings per inch.

| Loads applied. | Pounds per square inch. | Compression. | | Permanent set. | | Remarks. |
|---|---|---|---|---|---|---|
| | | Section A. | Section B. | Section A. | Section B. | |
| *Pounds.* | | *Inch.* | *Inch.* | *Inch.* | *Inch.* | |
| 3,000 | 100 | 0. | ..... | 0. | ..... | |
| 15,000 | 500 | .0033 | ..... | .0058 | ..... | |
| 30,000 | 1,000 | .0070 | ..... | .0139 | ..... | |
| ..... | 100 | ..... | 0. | ..... | .0008 | |
| 45,000 | 1,500 | .0105 | ..... | .0225 | ..... | |
| 60,000 | 2,000 | .0140 | ..... | .0315 | ..... | |
| ..... | 100 | ..... | 0. | ..... | .0025 | |
| 108,000 | 3,600 | ..... | ..... | ..... | ..... | Ultimate strength. |

Failed at knot 8″ from end.

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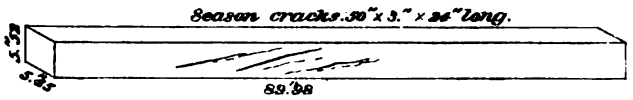
No. 562.

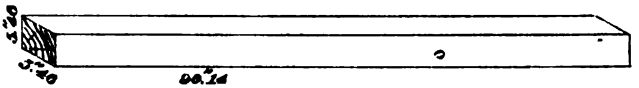



Sectional area, 30.1 square inches.
Gauged length, 50″
Weight, 72½ pounds.
Not counterweighted.

| Loads applied. | Pounds per square inch. | Compression. | Permanent set. | Remarks. |
|---|---|---|---|---|
| *Pounds.* | | *Inch.* | *Inch.* | |
| 3, 010 | 100 | 0. | | |
| 15, 050 | 500 | .0114 | | |
| | 100 | | 0. | |
| 30, 100 | 1, 000 | .0250 | | |
| | 100 | | 0. | |
| 45, 150 | 1, 500 | .0395 | | |
| | 100 | | .0005 | |
| 60, 200 | 2, 000 | .0537 | | |
| | 100 | | .0010 | |
| 140, 000 | 4, 651 | | | Ultimate strength. |

Failed by opening season cracks and crushing fibers.

No. 563.

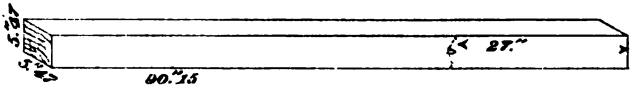


Sectional area, 29.8 square inches.
Gauged length, 50″.
Weight, 59½ pounds.
Not counterweighted.

| Loads applied. | Pounds per square inch. | Compression. | Permanent set. | Remarks. |
|---|---|---|---|---|
| *Pounds.* | | *Inch.* | *Inch.* | |
| 2, 980 | 100 | 0. | | |
| 14, 900 | 500 | .0123 | | |
| | 100 | | 0. | |
| 29, 800 | 1, 000 | .0280 | | |
| | 100 | | .0004 | |
| 44, 700 | 1, 500 | .0445 | | |
| | 100 | | .0010 | |
| 59, 600 | 2, 000 | .0621 | | |
| | 100 | | .0021 | |
| 124, 000 | 4, 161 | | | Ultimate strength. |

Failed at some knots 30″ from end.

No. 564.



Sectional area, 29.9 square inches.
Gauged length, 50″.
Weight, 57 pounds.
Not counterweighted.

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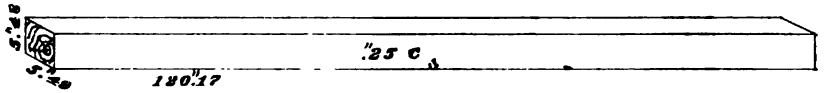
| Loads applied. | Pounds per square inch. | Compression. | Permanent set. | Remarks. |
|---|---|---|---|---|
| *Pounds.* | | *Inch.* | *Inch.* | |
| 2,990 | 100 | 0. | ..... | |
| 14,950 | 500 | .0100 | ..... | |
| ..... | 100 | ..... | 0. | |
| 29,900 | 1,000 | .0226 | ..... | |
| ..... | 100 | ..... | .0002 | |
| 44,850 | 1,500 | .0370 | ..... | |
| ..... | 100 | ..... | .0005 | |
| 59,800 | 2,000 | .0512 | ..... | |
| ..... | 100 | ..... | .0009 | |
| 143,500 | 4,799 | ..... | ..... | Ultimate strength. |

Crushed fibers at knot, 27″ from end.

No. 559.

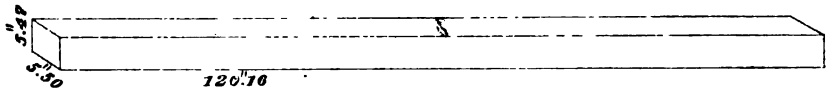



Sectional area, 30.1 square inches.
Gauged length, 100.″
Weight, 86 pounds.
Not counterweighted.
Initial deflection before dressed from size 6″×6″: Horizontal, ″.25.

| Loads applied. | Pounds per square inch. | Compression. | Permanent set. | Deflections. | | Remarks. |
|---|---|---|---|---|---|---|
| | | | | Horizontal. | Vertical. | |
| *Pounds.* | | *Inch.* | *Inch.* | *Inch.* | *Inch.* | |
| 3,010 | 100 | 0. | ..... | 0. | 0. | |
| 15,050 | 500 | .0190 | ..... | 0. | 0. | |
| ..... | 100 | ..... | 0. | 0. | 0. | |
| 30,100 | 1,000 | .0440 | ..... | 0. | .01 | |
| ..... | 100 | ..... | 0. | 0. | 0. | |
| 45,150 | 1,500 | .0700 | ..... | 0. | .01 | |
| ..... | 100 | ..... | .0002 | 0. | 0. | |
| 60,200 | 2,000 | .0964 | ..... | 0. | .01 | |
| ..... | 100 | ..... | .0010 | 0. | 0. | |
| 80,000 | ..... | ..... | ..... | 0. | .01 | |
| 100,000 | ..... | ..... | ..... | 0. | .01 | |
| 120,000 | ..... | ..... | ..... | .02 | .01 | |
| 140,000 | ..... | ..... | ..... | .07 | .04 | |
| 146,200 | 4,857 | ..... | ..... | .15 | .15 | Ultimate strength. |

Failed by deflecting upwards, crushing fibers in the vicinity of knots at middle of post.

No. 560.




Sectional area, 30.1 square inches.
Gauged length, 100″.
Weight, 88½ pounds.
Not counterweighted.
Cross-grained stick with season cracks.

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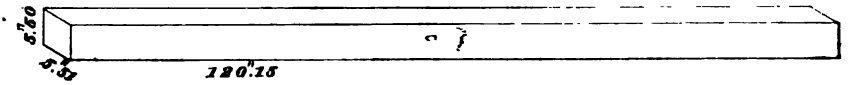
| Loads applied. | Pounds per square inch. | Compression. | Permanent set. | Deflections. | | Remarks. |
|---|---|---|---|---|---|---|
| | | | | Horizontal. | Vertical. | |
| *Pounds.* | | *Inch.* | *Inch.* | *Inch.* | *Inch.* | |
| 3,010 | 100 | 0. | | 0. | 0. | |
| 15,050 | 500 | .0207 | | —.01 | —.03 | |
| | 100 | | .0010 | 0. | 0. | |
| 30,100 | 1,000 | .0480 | | —.04 | —.10 | |
| | 100 | | .0010 | | | |
| 45,150 | 1,500 | .0750 | | —.06 | —.16 | |
| | 100 | | .0018 | 0. | 0 | |
| 60,200 | 2,000 | .1030 | | —.06 | —.21 | |
| | 100 | | .0025 | 0. | 0. | |
| 70,000 | | | | —.07 | —.28 | |
| 80,000 | | | | —.07 | —.34 | |
| 90,000 | | | | —.06 | —.40 | |
| 100,000 | | | | —.05 | —.46 | |
| 110,000 | | | | —.05 | —.46 | |
| 120,000 | | | | | —.70 | |
| 130,000 | | | | | —.90 | |
| 139,000 | 4,618 | | | | | Ultimate strength. |

Failed, crushing fibers at knot at middle of post; deflected downward.

No. 561.




Sectional area, 30.3 square inches.
Gauged length, 100″.
Weight, 110 pounds.
Not counterweighted.
Worm-eaten post.

| Loads applied. | Pounds per square inch. | Compression. | Permanent set. | Deflections. | | Remarks. |
|---|---|---|---|---|---|---|
| | | | | Horizontal. | Vertical. | |
| *Pounds.* | | *Inch.* | *Inch.* | *Inch.* | *Inch.* | |
| 3,030 | 100 | 0. | | 0. | 0. | |
| 15,150 | 500 | .0164 | | —.01 | 0. | |
| | 100 | | 0. | 0. | 0. | |
| 30,300 | 1,000 | .0385 | | —.01 | 0. | |
| | 100 | | 0. | 0. | 0. | |
| 45,450 | 1,500 | .0600 | | —.02 | —.02 | |
| | 100 | | 0. | 0. | 0. | |
| 60,600 | 2,000 | .0820 | | —.02 | —.04 | |
| | 100 | | .0010 | 0. | 0. | |
| 70,000 | | | | —.02 | —.05 | |
| 80,000 | | | | —.04 | —.06 | |
| 90,000 | | | | —.05 | —.07 | |
| 100,000 | | | | —.05 | —.09 | |
| 110,000 | | | | —.05 | —.10 | |
| 120,000 | | | | —.06 | —.11 | |
| 130,000 | | | | —.07 | —.12 | |
| 140,000 | | | | —.10 | —.13 | |
| 143,600 | 4,739 | | | | | Ultimate strength. |

Failed by crushing fibers in vicinity of knot at middle of post.

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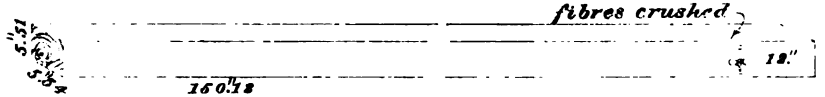
## No. 556.

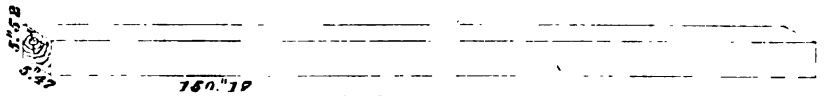



Sectional area, 30.5 square inches.
Weight, 126 pounds.
Gauged length, 100″.
Counterweight at middle, 64 pounds.

| Loads applied. | Pounds per square inch. | Compression. | Permanent set. | Deflections. | | Remarks. |
|---|---|---|---|---|---|---|
| | | | | Horizontal. | Vertical. | |
| *Pounds.* | | *Inch.* | *Inch.* | *Inch.* | *Inch.* | |
| 3,050 | 100 | 0. | ..... | 0. | 0. | |
| 15,250 | 500 | .0190 | ..... | .01 | 0. | |
| ..... | 100 | ..... | 0. | 0. | 0. | |
| 30,500 | 1,000 | .0438 | ..... | .03 | 0. | |
| ..... | 100 | ..... | −.0006 | 0. | 0. | |
| 45,550 | 1,500 | .0680 | ..... | .05 | 0. | |
| ..... | 100 | ..... | .0004 | 0. | 0. | |
| 61,000 | 2,000 | .0932 | ..... | .08 | 0. | |
| ..... | 100 | ..... | .0002 | 0. | 0. | |
| 70,000 | ..... | ..... | ..... | .09 | 0. | |
| 80,000 | ..... | ..... | ..... | .11 | 0. | |
| 90,000 | ..... | ..... | ..... | .14 | 0. | |
| 100,000 | ..... | ..... | ..... | .16 | 0. | |
| 110,000 | ..... | ..... | ..... | .19 | 0. | |
| 120,000 | ..... | ..... | ..... | .23 | 0. | |
| 130,000 | ..... | ..... | ..... | .28 | −.02 | |
| 140,000 | ..... | ..... | ..... | .35 | −.05 | |
| 150,000 | ..... | ..... | ..... | .49 | −.11 | |
| 156,000 | 5,114 | ..... | ..... | .85 | −.11 | Ultimate strength. |

Failed by deflection sideways. Crushed fibers at knot 12″ from end of post.

## No. 557.



Sectional area, 30.2 square inches.
Gauged length, 100″.
Weight, 128 pounds.
Counterweight at middle, 64 pounds.

| Loads applied. | Pounds per square inch. | Compression. | Permanent set. | Deflections. | | Remarks. |
|---|---|---|---|---|---|---|
| | | | | Horizontal. | Vertical. | |
| *Pounds.* | | *Inch.* | *Inch.* | *Inch.* | *Inch.* | |
| 3,020 | 100 | 0. | ..... | 0. | 0. | |
| 15,100 | 500 | .0166 | ..... | 0. | 0. | |
| ..... | 100 | ..... | 0. | 0. | 0. | |
| 30,200 | 1,000 | .0386 | ..... | 0. | 0. | |
| ..... | 100 | ..... | .0007 | 0. | 0. | |
| 45,300 | 1,500 | .0610 | ..... | −.02 | −.01 | |
| ..... | 100 | ..... | .0009 | 0. | 0 | |
| 60,400 | 2,000 | .0840 | ..... | −.04 | −.03 | |
| ..... | 100 | ..... | .0010 | 0. | 0. | |
| 70,000 | ..... | ..... | ..... | −.05 | −.04 | |
| 80,000 | ..... | ..... | ..... | −.06 | −.06 | |
| 100,000 | ..... | ..... | ..... | −.10 | −.10 | |
| 110,000 | ..... | ..... | ..... | −.11 | −.11 | |
| 120,000 | ..... | ..... | ..... | −.14 | −.13 | |
| 130,000 | ..... | ..... | ..... | −.18 | −.16 | |
| 140,000 | ..... | ..... | ..... | −.24 | −.20 | |
| 150,000 | ..... | ..... | ..... | −.34 | −.29 | |
| 156,000 | 5,166 | ..... | ..... | −.70 | −.50 | Ultimate strength. |

Failed by deflecting diagonally downward and sideways.

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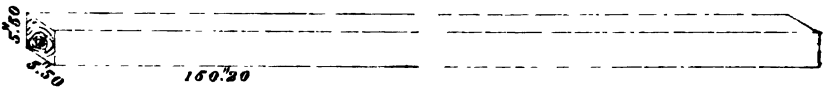
No. 558.

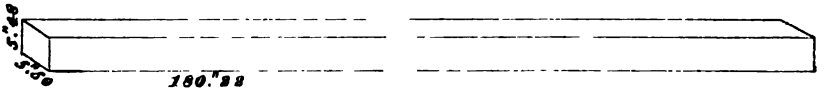



Sectional area, 30.3 square inches.
Gauged length, 100″.
Weight, 141½ pounds.
Counterweight at middle, 64 pounds.

| Loads applied. | Pounds per square inch. | Compression. | Permanent set. | Deflections. | | Remarks. |
|---|---|---|---|---|---|---|
| | | | | Horizontal. | Vertical. | |
| *Pounds.* | | *Inch.* | *Inch.* | *Inch.* | *Inch.* | |
| 3,030 | 100 | 0. | ..... | 0. | 0. | |
| 15,150 | 500 | .0172 | ..... | — .07 | 0. | |
| ..... | 100 | ..... | 0. | 0. | 0. | |
| 30,300 | 1,000 | .0400 | ..... | — .12 | 0. | |
| ..... | 100 | ..... | — .0004 | — .01 | 0. | |
| 45,450 | 1,500 | .0629 | ..... | — .17 | 0. | |
| ..... | 100 | ..... | — .0003 | — .01 | 0. | |
| 60,600 | 2,000 | .0865 | ..... | — .19 | — .02 | |
| ..... | 100 | ..... | — .0002 | — .01 | 0. | |
| 70,000 | ..... | ..... | ..... | — .21 | — .04 | |
| 80,000 | ..... | ..... | ..... | — .22 | — .05 | |
| 90,000 | ..... | ..... | ..... | — .25 | — .06 | |
| 100,000 | ..... | ..... | ..... | — .27 | — .08 | |
| 110,000 | ..... | ..... | ..... | — .29 | — .09 | |
| 120,000 | ..... | ..... | ..... | — .31 | — .10 | |
| 130,000 | ..... | ..... | ..... | — .36 | — .11 | |
| 140,000 | ..... | ..... | ..... | — .40 | — .12 | |
| 150,000 | 4,950 | ..... | ..... | — .66 | — .12 | Ultimate strength. |

Failed by deflecting sideways and upwards, changing the direction of the vertical deflections after passing the maximum load.

No. 553.



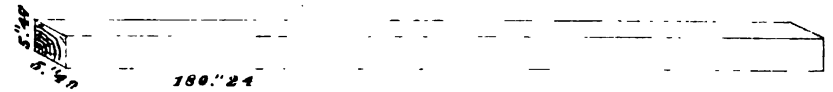

Sectional area, 30.1 square inches.
Weight, 140 pounds.
Gauged length, 100″.
Counterweight at middle, 64 pounds.

| Loads applied. | Pounds per square inch. | Compression. | Permanent set. | Deflections. | | Remarks. |
|---|---|---|---|---|---|---|
| | | | | Horizontal. | Vertical. | |
| *Pounds.* | | *Inch.* | *Inch.* | *Inch.* | *Inch.* | |
| 3,010 | 100 | 0. | ..... | 0. | 0. | |
| 15,050 | 500 | .0230 | ..... | .01 | .04 | |
| ..... | 100 | ..... | .0002 | 0. | 0. | |
| 30,100 | 1,000 | .0552 | ..... | .01 | .05 | |
| ..... | 100 | ..... | 0. | 0. | .01 | |
| 40,000 | ..... | ..... | ..... | + .02 | .06 | |
| 50,000 | ..... | ..... | ..... | + .02 | .07 | |
| 60,000 | ..... | ..... | ..... | + .02 | .07 | |
| 70,000 | ..... | ..... | ..... | .04 | .04 | |
| 80,000 | ..... | ..... | ..... | .05 | 0. | |
| 90,000 | ..... | ..... | ..... | .08 | — .10 | |
| 99,200 | 3,296 | ..... | ..... | .27 | — .80 | Ultimate strength. |

Failed by deflecting downward.

Digitized by Google

No. 554.

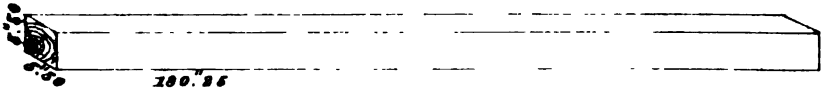



Sectional area, 30 square inches.
Gauged length, 100″.
Weight, 148 pounds.
Counterweight at middle, 76 pounds.

| Loads applied. | Pounds per square inch. | Compression. | Permanent set. | Deflections. Horizontal. | Deflections. Vertical. | Remarks. |
|---|---|---|---|---|---|---|
| *Pounds.* | | *Inch.* | *Inch.* | *Inch.* | *Inch.* | |
| 3,000 | 100 | 0. | ..... | .03 | .03 | |
| 15,000 | 500 | .0189 | ..... | .03 | .03 | |
| ..... | 100 | ..... | 0. | .03 | .03 | |
| 30,000 | 1,000 | .0435 | ..... | .03 | .01 | |
| ..... | 100 | ..... | 0. | .03 | .03 | |
| 45,000 | 1,500 | .0688 | ..... | .03 | 0. | |
| ..... | 100 | ..... | .0002 | .03 | .03 | |
| 60,000 | 2,000 | .0935 | ..... | .04 | — .02 | |
| ..... | 100 | ..... | 0. | .03 | .03 | |
| 70,000 | ..... | ..... | ..... | .05 | — .02 | |
| 80,000 | ..... | ..... | ..... | .07 | — .03 | |
| 90,000 | ..... | ..... | ..... | .07 | — .04 | |
| 100,000 | ..... | ..... | ..... | .10 | — .06 | |
| 110,000 | ..... | ..... | ..... | .13 | — .07 | |
| 120,000 | ..... | ..... | ..... | .20 | — .08 | |
| 130,000 | 4,333 | ..... | ..... | .52 | — .02 | Ultimate strength. |

Failed by deflecting sideways, reversing the vertical deflections and bending upward slightly.

No. 555.




Sectional area, 30.3 square inches.
Gauged length, 100″.
Weight, 148 pounds.
Counterweight at middle, 76 pounds.

| Loads applied. | Pounds per square inch. | Compression. | Permanent set. | Deflections. Horizontal. | Deflections. Vertical. | Remarks. |
|---|---|---|---|---|---|---|
| *Pounds.* | | *Inch.* | *Inch.* | *Inch.* | *Inch.* | |
| 3,030 | 100 | 0. | ..... | 0. | 0. | |
| 15,150 | 500 | .0200 | ..... | — .02 | — .01 | |
| ..... | 100 | ..... | 0. | 0. | 0. | |
| 30,300 | 1,000 | .0450 | ..... | — .05 | — .02 | |
| ..... | 100 | ..... | 0. | 0. | 0. | |
| 45,450 | 1,500 | .0706 | ..... | — .05 | — .02 | |
| ..... | 100 | ..... | .0011 | — .01 | 0. | |
| 60,600 | 2,000 | .0970 | ..... | — .06 | — .02 | |
| ..... | 100 | ..... | .0016 | — .01 | 0. | |
| 70,000 | ..... | ..... | ..... | — .07 | — .02 | |
| 80,000 | ..... | ..... | ..... | — .07 | — .02 | |
| 90,000 | ..... | ..... | ..... | — .07 | — .03 | |
| 100,000 | ..... | ..... | ..... | — .08 | — .04 | |
| 110,000 | ..... | ..... | ..... | — .11 | — .06 | |
| 120,000 | ..... | ..... | ..... | — .16 | — .09 | |
| 129,000 | 4,257 | ..... | ..... | — .50 | — .30 | Ultimate strength. |

Failed by deflecting diagonally downward and sideways.



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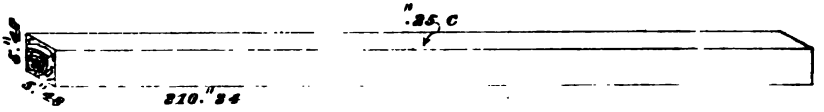
No. 550.

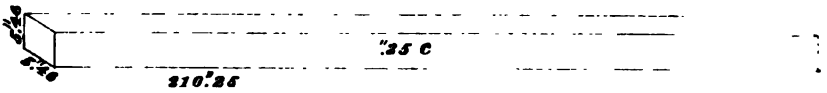



Sectional area, 30 square inches.
Weight, 172 pounds.
Counterweight at middle, 88 pounds.
Initial deflection before stick was dressed down from size 6″ × 6″: Vertical, — ″.25.

| Loads applied. | Pounds per square inch. | Compression. | Permanent set. | Deflections. | | Remarks. |
|---|---|---|---|---|---|---|
| | | | | Horizontal. | Vertical. | |
| *Pounds.* | | *Inch.* | *Inch.* | *Inch.* | *Inch.* | |
| 2,000 | | | | — .06 | — .08 | |
| 4,000 | | | | — .06 | — .06 | |
| 6,000 | | | | — .06 | — .05 | |
| 8,000 | | | | — .06 | — .04 | |
| 10,000 | | | | — .06 | — .02 | |
| 14,000 | | | | — .06 | — .01 | |
| 18,000 | | | | — .07 | 0. | |
| 20,000 | | | | — .08 | 0. | |
| 22,000 | | | | — .09 | 0. | |
| 26,000 | | | | — .10 | 0. | |
| 30,000 | | | | — .10 | 0. | |
| 34,000 | | | | — .11 | 0. | |
| 38,000 | | | | — .13 | 0. | |
| 40,000 | | | | — .15 | 0. | |
| 50,000 | | | | — .20 | 0. | |
| 60,000 | | | | — .26 | 0. | |
| 70,000 | | | | — .35 | 0. | |
| 80,000 | | | | — .51 | — .01 | |
| 90,000 | 8,000 | | | —1.03 | — .06 | Ultimate strength. |

Failed suddenly under the maximum load, deflecting sideways, splitting the stick at the middle where it was cross-grained.

No. 551.




Sectional area, 29.8 square inches.
Weight, 180½ pounds.
Counterweight at middle, 88 pounds.
Initial deflection before stick was dressed down from size 6″ × 6″: Horizontal, ″.25.

| Loads applied. | Pounds per square inch. | Deflections. | | Remarks. |
|---|---|---|---|---|
| | | Horizontal. | Vertical. | |
| *Pounds.* | | *Inch.* | *Inch.* | |
| 2,000 | | .09 | .09 | |
| 4,000 | | .09 | .09 | |
| 6,000 | | .10 | .09 | |
| 8,000 | | .10 | .09 | |
| 10,000 | | .10 | .09 | |
| 14,000 | | .11 | .09 | |

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| Loads applied. | Pounds per square inch. | Deflections. | | Remarks. |
|---|---|---|---|---|
| | | Horizontal. | Vertical. | |
| *Pounds.* | | *Inch.* | *Inch.* | |
| 18,000 | ..... | .11 | .09 | |
| 22,000 | ..... | .12 | .09 | |
| 26,000 | ..... | .13 | .09 | |
| 30,000 | ..... | .14 | .09 | |
| 40,000 | ..... | .17 | .09 | |
| 50,000 | ..... | .21 | .10 | |
| 60,000 | ..... | .26 | .10 | |
| 70,000 | ..... | .33 | .11 | |
| 80,000 | ..... | .45 | .12 | |
| 90,000 | ..... | .60 | .14 | |
| 100,000 | ..... | .89 | .20 | |
| 109,000 | 3 658 | 1.95 | .50 | Ultimate strength. |

Deflected sideways.

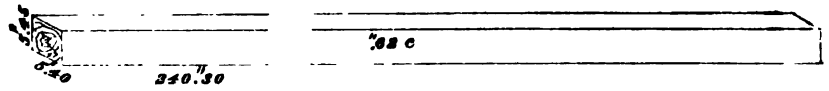
No. 552.

Sectional area, 30.3 square inches.
Weight, 167½ pounds.
Counterweight at middle, 88 pounds.

| Loads applied. | Pounds per square inch. | Deflections. | | Remarks. |
|---|---|---|---|---|
| | | Horizontal. | Vertical. | |
| *Pounds.* | | *Inch.* | *Inch.* | |
| 2,000 | ..... | 0. | 0. | |
| 4,000 | ..... | 0. | 0. | |
| 6,000 | ..... | 0. | 0. | |
| 8,000 | ..... | 0. | 0. | |
| 10,000 | ..... | 0. | 0. | |
| 14,000 | ..... | —.01 | 0. | |
| 18,000 | ..... | —.01 | 0. | |
| 22,000 | ..... | —.02 | .01 | |
| 26,000 | ..... | —.03 | .01 | |
| 30,000 | ..... | —.03 | .01 | |
| 40,000 | ..... | —.05 | .01 | |
| 50,000 | ..... | —.06 | .01 | |
| 60,000 | ..... | —.09 | .01 | |
| 70,000 | ..... | —.14 | .01 | |
| 80,000 | ..... | —.25 | .01 | |
| 90,000 | ..... | —.52 | .01 | |
| 93,000 | 3,069 | —1.42 | .01 | Ultimate strength. |

Deflected horizontally.

No. 548.



Sectional area, 29.4 square inches.
Weight, 185 pounds.
Counterweight at middle, 88 pounds.
Initial deflection before stick was dressed down from size 6″×6″: Horizontal, + ″.62.

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| Loads applied. | Pounds per square inch. | Deflections. Horizontal. | Deflections. Vertical. | Remarks. |
|---|---|---|---|---|
| *Pounds.* | | *Inch.* | *Inch.* | |
| 2,000 | ..... | 0. | 0. | |
| 4,000 | ..... | —.05 | .01 | |
| 6,000 | ..... | —.07 | .02 | |
| 8,000 | ..... | —.08 | .02 | |
| 10,000 | ..... | —.09 | .02 | |
| 14,000 | ..... | —.10 | .02 | |
| 18,000 | ..... | —.11 | .02 | |
| 22,000 | ..... | —.13 | .02 | |
| 26,000 | ..... | —.15 | .02 | |
| 30,008 | ..... | —.17 | .02 | |
| 34,000 | ..... | —.19 | .02 | |
| 38,000 | ..... | —.20 | .01 | |
| 42,000 | ..... | —.23 | .01 | |
| 46,000 | ..... | —.25 | 0. | |
| 50,000 | ..... | —.30 | 0. | |
| 54,000 | ..... | —.32 | 0. | |
| 56,000 | ..... | —.35 | 0. | |
| 58,000 | ..... | —.36 | 0. | |
| 62,000 | ..... | —.40 | 0. | |
| 66,000 | ..... | —.50 | 0. | |
| 70,000 | ..... | —.60 | 0. | |
| 74,000 | ..... | —.75 | 0. | |
| 78,000 | ..... | —1.00 | .05 | |
| 80,000 | ..... | —1.28 | .08 | |
| 82,000 | 2,789 | ..... | ..... | Ultimate strength. |

Failed by deflecting sideways.

No. 549.

Sectional area, 29.8 square inches.
Weight, 185 pounds.
Counterweight at middle, 88 pounds.
Post was $\frac{3}{8}''$ winding before dressed down from size $6'' \times 6''$.

| Loads applied. | Pounds per square inch. | Deflections. Horizontal. | Deflections. Vertical. | Remarks. |
|---|---|---|---|---|
| *Pounds.* | | *Inch.* | *Inch.* | |
| 2,000 | ..... | —.04 | —.06 | |
| 4,000 | ..... | —.05 | —.08 | |
| 6,000 | ..... | —.05 | —.10 | |
| 8,000 | ..... | —.05 | —.11 | |
| 10,000 | ..... | —.05 | —.12 | |
| 14,000 | ..... | —.05 | —.13 | |
| 18,000 | ..... | —.05 | —.14 | |
| 22,000 | ..... | —.06 | —.15 | |
| 26,000 | ..... | —.06 | —.16 | |
| 30,000 | ..... | —.07 | —.18 | |
| 40,000 | ..... | —.09 | —.22 | |
| 50,000 | ..... | —.11 | —.29 | |
| 54,000 | ..... | —.16 | —.40 | |
| 66,000 | ..... | —.18 | —.41 | |
| 68,000 | ..... | —.20 | —.43 | |
| 70,000 | ..... | —.21 | —.48 | |
| 72,000 | ..... | —.22 | —.52 | |
| 74,000 | ..... | —.25 | —.58 | |
| 76,000 | ..... | —.26 | —.61 | |
| 78,000 | ..... | —.30 | —.67 | |
| 80,000 | ..... | —.34 | —.75 | |
| 82,000 | ..... | —.37 | —.83 | |
| 84,000 | ..... | —.45 | —.96 | |
| 86,000 | ..... | —.56 | —1.13 | |
| 87,800 | 2,946 | —.97 | —1.59 | Ultimate strength. |

Deflected downward and sideways.

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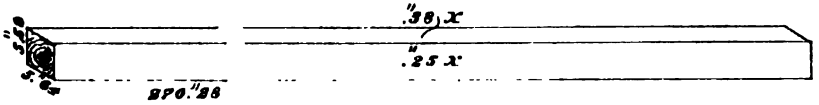
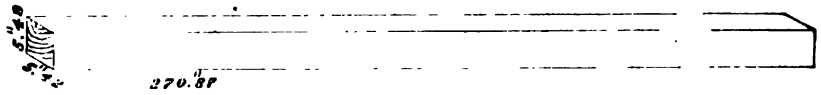
No. 545.



Sectional area, 31.5 square inches.
Weight, 212 pounds.
Counterweight at middle, 108 pounds.
Initial deflections before stick was dressed down from size 6″×6″: Horizontal, —″.25; vertical, +″.38.

| Loads applied. | Pounds per square inch. | Deflections. Horizontal. | Deflections. Vertical. | Remarks. |
|---|---|---|---|---|
| *Pounds.* | | *Inch.* | *Inch.* | |
| 2,000 | | —.10 | 0. | |
| 4,000 | | —.10 | 0. | |
| 6,000 | | —.10 | 0. | |
| 8,000 | | —.10 | .01 | |
| 10,000 | | —.11 | .01 | |
| 12,000 | | —.11 | .01 | |
| 16,000 | | —.12 | .01 | |
| 20,000 | | —.15 | .02 | |
| 24,000 | | —.16 | .02 | |
| 28,000 | | —.18 | .03 | |
| 30,000 | | —.20 | .03 | |
| 32,000 | | —.20 | .04 | |
| 34,000 | | —.22 | .04 | |
| 36,000 | | —.23 | .04 | |
| 38,000 | | —.25 | .05 | |
| 40,000 | | —.27 | .06 | |
| 42,000 | | —.28 | .07 | |
| 44,000 | | —.30 | .08 | |
| 46,000 | | —.32 | .09 | |
| 48,000 | | —.34 | .10 | |
| 50,000 | | —.36 | .11 | |
| 52,000 | | —.38 | .12 | |
| 54,000 | | —.40 | .13 | |
| 56,000 | | —.45 | .14 | |
| 58,000 | | —.49 | .16 | |
| 60,000 | | —.54 | .19 | |
| 62,000 | | —.60 | .21 | |
| 64,000 | | —.68 | .25 | |
| 66,000 | | —.75 | .30 | |
| 68,000 | | —.86 | .34 | |
| 70,000 | | —1.00 | .43 | |
| 73,700 | 2,340 | —1.75 | .90 | Ultimate strength. |
| | | —2.80 | 1.80 | Sudden spring when deflection reached this amount, sustaining about 60,000 pounds at the time. |

No. 546.



Sectional area, 29.8 square inches.
Weight, 189 pounds.
Counterweight at middle, 96 pounds.
This stick was ¾″ winding before dressing down from size 6″×6″.

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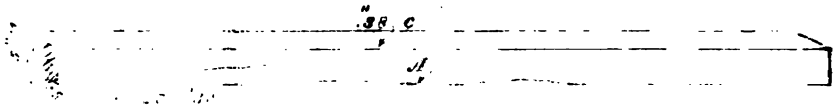
| Loads applied. | Pounds per square inch. | Deflections. Horizontal. | Deflections. Vertical. | Remarks. |
|---|---|---|---|---|
| *Pounds.* | | *Inch.* | *Inch.* | |
| 2,000 | | .04 | 0 | |
| 4,000 | | .07 | .03 | |
| 6,000 | | .09 | .06 | |
| 8,000 | | .09 | .08 | |
| 10,000 | | .09 | .09 | |
| 14,000 | | .09 | .11 | |
| 18,000 | | .09 | .13 | |
| 22,000 | | .09 | .16 | |
| 26,000 | | .09 | .19 | |
| 30,000 | | .09 | .22 | |
| 34,000 | | .09 | .26 | |
| 38,000 | | .09 | .31 | |
| 42,000 | | .06 | .37 | |
| 46,000 | | .03 | .47 | |
| 50,000 | | −.02 | .65 | |
| 54,000 | | −.16 | .98 | |
| 56,000 | 1,879 | −.50 | | Ultimate strength. |

Failed by vertical deflection.

## No. 547.




Sectional area, 31.7 square inches.

Weight, 266 pounds.

Counterweight at middle, 140 pounds.

Initial deflection before stick was dressed down from size 6″ × 6″: Vertical, −″.38.

| Loads applied. | Pounds per square inch. | Deflections. Horizontal. | Deflections. Vertical. | Remarks. |
|---|---|---|---|---|
| *Pounds.* | | *Inch.* | *Inch.* | |
| 2,000 | | −.20 | −.14 | |
| 4,000 | | −.20 | −.12 | |
| 6,000 | | −.20 | −.10 | |
| 8,000 | | −.20 | −.10 | |
| 10,000 | | −.20 | −.09 | |
| 14,000 | | −.20 | −.09 | |
| 18,000 | | −.20 | −.10 | |
| 22,000 | | −.20 | −.10 | |
| 26,000 | | −.21 | −.10 | |
| 30,000 | | −.21 | −.10 | |
| 34,000 | | −.22 | −.10 | |
| 38,000 | | −.22 | −.10 | |
| 42,000 | | −.25 | −.10 | |
| 46,000 | | −.26 | −.10 | Snapping sounds. |
| 50,000 | | −.27 | −.10 | |
| 54,000 | | −.30 | −.11 | |
| 58,000 | | −.27 | −.15 | |
| 62,000 | | −.20 | −.15 | |
| 62,500 | 1,972 | | | Ultimate strength. |

Failed by deflecting sideways in plus direction and upwards.

Before the maximum load was reached, crack at A opened on the convex side corner about ½ square inch, splintering partly off, forming a loop. At the time of maximum load this splinter broke by compression and at the same time the deflections were reversed, changing from minus to plus directions, the splintering corner now being on the concave side.

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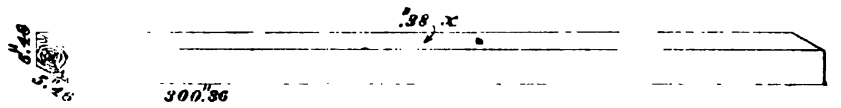
No. 508.




Sectional area, 29.9 square inches.
Weight, 210 pounds.
Counterweight at middle, 105 pounds.
Initial deflection before dressing down from size 6″×6″: Vertical, +″.38.

| Loads applied. | Pounds per square inch. | Deflections. Horizontal. | Deflections. Vertical. | Remarks. |
|---|---|---|---|---|
| *Pounds.* | | *Inch.* | *Inch.* | |
| 2,000 | | + .18 | + .12 | |
| 4,000 | | + .18 | + .12 | |
| 6,000 | | + .18 | + .12 | |
| 8,000 | | + .18 | + .12 | |
| 10,000 | | + .18 | + .12 | |
| 12,000 | | .20 | + .12 | |
| 14,000 | | .21 | + .12 | |
| 16,000 | | .22 | + .12 | |
| 18,000 | | .24 | .13 | |
| 20,000 | | .25 | .14 | |
| 22,000 | | .29 | .15 | |
| 24,000 | | .30 | .17 | |
| 26,000 | | .33 | .18 | |
| 28,000 | | .36 | .18 | |
| 30,000 | | .40 | .19 | |
| 32,000 | | .45 | .20 | |
| 34,000 | | .50 | .20 | |
| 36,000 | | .55 | .22 | |
| 38,000 | | .59 | .23 | |
| 40,000 | | .67 | .25 | |
| 42,000 | | .76 | .27 | |
| 44,000 | | .89 | .30 | |
| 45,000 | | .97 | .32 | Snapping sounds. |
| 46,000 | | 1.06 | .33 | |
| 47,000 | | 1.17 | .35 | |
| 48,000 | | 1.30 | .38 | |
| 49,000 | | 1.45 | .40 | |
| 50,000 | | 1.68 | .44 | |
| 51,000 | | 1.95 | .50 | |
| 52,000 | 1,739 | 2.40 | .56 | Ultimate strength. |

Failed by deflecting sideways and upward.

No. 509.

Sectional area, 30 square inches.
Weight, 235 pounds.
Counterweight at middle, 117 pounds.

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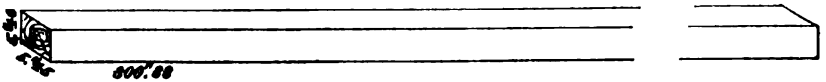
| Loads applied. | Pounds per square inch. | Deflections. Horizontal. | Deflections. Vertical. | Remarks. |
|---|---|---|---|---|
| *Pounds.* | | *Inch.* | *Inch.* | |
| 2,000 | | − .08 | 0. | |
| 4,000 | | − .12 | 0. | |
| 6,000 | | − .14 | .01 | |
| 8,000 | | − .15 | .02 | |
| 10,000 | | − .17 | .02 | |
| 12,000 | | − .18 | .03 | |
| 14,000 | | − .18 | .04 | |
| 16,000 | | − .18 | .05 | |
| 18,000 | | − .18 | .05 | |
| 20,000 | | − .19 | .05 | |
| 22,000 | | − .20 | .06 | |
| 24,000 | | − .20 | .06 | |
| 26,000 | | − .21 | .07 | |
| 28,000 | | − .22 | .08 | |
| 30,000 | | − .23 | .09 | |
| 32,000 | | − .25 | .10 | |
| 34,000 | | − .26 | .10 | |
| 36,000 | | − .28 | .10 | |
| 38,000 | | − .30 | .11 | |
| 40,000 | | − .32 | .11 | |
| 42,000 | | − .34 | .11 | |
| 44,000 | | − .36 | .11 | |
| 46,000 | | − .40 | .11 | |
| 48,000 | | − .45 | .11 | |
| 50,000 | | − .51 | .11 | |
| 52,000 | | − .64 | .12 | |
| 54,000 | | − .78 | .12 | |
| 56,000 | | −1.00 | .12 | |
| 58,000 | | −1.48 | .12 | |
| 59,000 | 1,967 | −2.12 | .11 | Ultimate strength. |

## No. 510.



Sectional area, 29.8 square inches.
Weight, 210 pounds.
Counterweight at middle, 105 pounds.
Post ".38 winding before dressing down from size 6″ × 6″.

| Loads applied | Pounds per square inch. | Deflections. Horizontal. | Deflections. Vertical. | Remarks. |
|---|---|---|---|---|
| *Pounds.* | | *Inch.* | *Inch.* | |
| 2,000 | | − .04 | + .05 | |
| 4,000 | | − .01 | + .05 | |
| 6,000 | | 0. | .04 | |
| 8,000 | | 0. | .02 | |
| 10,000 | | 0. | 0. | |
| 12,000 | | 0. | 0. | |
| 14,000 | | 0. | 0. | |
| 16,000 | | + .01 | − .02 | |
| 18,000 | | .02 | − .04 | |
| 20,000 | | .02 | − .05 | |
| 22,000 | | .03 | − .06 | |
| 24,000 | | .04 | − .07 | |
| 26,000 | | .06 | − .08 | |
| 28,000 | | .08 | − .09 | |
| 30,000 | | .10 | − .10 | |
| 32,000 | | .12 | − .11 | |
| 34,000 | | .13 | − .12 | |
| 36,000 | | .15 | − .13 | |
| 38,000 | | .18 | − .15 | |
| 40,000 | | .22 | − .16 | |
| 42,000 | | .26 | − .17 | |
| 44,000 | | .30 | − .18 | |
| 46,000 | | .40 | − .20 | |
| 48,000 | | .50 | − .20 | |
| 50,000 | | .63 | − .20 | |
| 51,000 | | .75 | − .20 | |
| 53,000 | | 1.05 | − .21 | |
| 54,000 | | 1.38 | − .21 | |
| 55,000 | | 1.63 | − .20 | |
| 55,500 | 1,862 | | | Ultimate strength. |

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## No. 499.

Sectional area, 28.1 square inches.
Weight, 258 pounds.
Counterweight at middle, 129 pounds.
Initial bend in post before dressing down from size 3″×6″: Vertical, +″.38.

| Loads applied. | Pounds per square inch. | Deflections. Horizontal. | Deflections. Vertical. | Remarks. |
|---|---|---|---|---|
| *Pounds.* | | *Inch.* | *Inch.* | |
| 2,000 | | 0. | + .30 | |
| 3,000 | | 0. | .30 | |
| 4,000 | | — .02 | .24 | |
| 5,000 | | — .05 | .20 | |
| 6,000 | | — .08 | .16 | |
| 7,000 | | — .08 | .15 | |
| 8,000 | | — .08 | .13 | |
| 9,000 | | — .07 | .12 | |
| 10,000 | | — .07 | .10 | |
| 11,000 | | — .07 | .10 | |
| 12,000 | | — .08 | .10 | |
| 13,000 | | — .08 | .10 | |
| 14,000 | | — .08 | .10 | |
| 15,000 | | — .08 | .08 | |
| 16,000 | | — .08 | .08 | |
| 17,000 | | — .08 | .08 | |
| 18,000 | | — .08 | .08 | |
| 19,000 | | — .08 | .08 | |
| 20,000 | | — .08 | .08 | |
| 21,000 | | — .08 | .08 | |
| 22,000 | | — .08 | .08 | |
| 23,000 | | — .08 | .08 | |
| 24,000 | | — .08 | .08 | |
| 25,000 | | — .08 | .08 | |
| 26,000 | | — .08 | .08 | |
| 27,000 | | — .08 | .07 | |
| 28,000 | | — .08 | .07 | |
| 29,000 | | — .08 | .06 | |
| 30,000 | | — .08 | .06 | |
| 31,000 | | — .08 | .06 | |
| 32,000 | | — .06 | .05 | |
| 33,000 | | — .06 | .05 | |
| 34,000 | | — .06 | .05 | |
| 35,000 | | — .05 | .05 | |
| 36,000 | | — .04 | .05 | |
| 37,000 | | — .04 | .05 | |
| 38,000 | | — .02 | .05 | |
| 39,000 | | — .02 | .05 | |
| 40,000 | | — .02 | .04 | |
| 41,000 | | — .02 | .04 | |
| 42,000 | | 0 | .04 | |
| 43,000 | | 0 | .04 | |
| 44,000 | | 0 | .03 | |
| 45,000 | | 0 | .02 | |
| 46,000 | | + .02 | .01 | |
| 47,000 | | .05 | .01 | |
| 48,000 | | .06 | 0. | |
| 49,000 | | .08 | 0. | |
| 50,000 | | .10 | 0. | |
| 51,000 | | .12 | 0. | |
| 52,000 | | .15 | 0. | |
| 53,000 | | .19 | 0. | |
| 54,000 | | .21 | 0. | |
| 55,000 | | .27 | 0. | |
| 56,000 | | .32 | 0. | |
| 57,000 | | .44 | 0. | |
| 58,000 | | .55 | 0. | |
| 59,000 | | .72 | — .03 | |
| 60,000 | | 1.00 | — .03 | |
| 60,800 | 2,163 | 2.00 | — .03 | Ultimate strength. |

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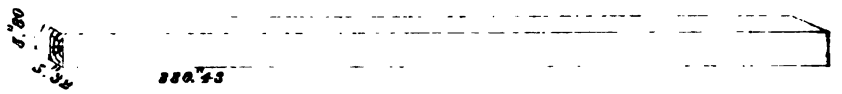
Failed by horizontal deflection, suddenly springing when the maximum load was reached, increasing the horizontal deflection to about 8″. Load released to 10,000 pounds and maximum loads repeated, sudden springing occurring when the following loads were reached: 56,000, 54,000, and 53,000 pounds.

Between each loading, strains were released to 10,000 pounds.

No. 500.



Sectional area, 28.2 square inches.

Weight, 236 pounds.

Counterweight at middle, 118 pounds.

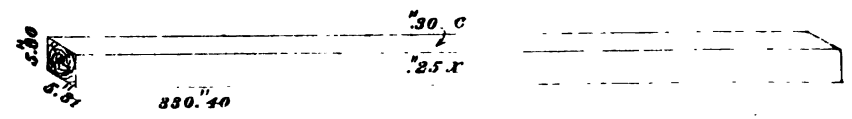
Initial bend before dressing down from 6″×6″ stick: Horizontal, —″.38; post winding, ″.38.

| Loads applied. | Pounds per square inch. | Deflections. Horizontal. | Deflections. Vertical. | Remarks. |
|---|---|---|---|---|
| *Pounds.* | | *Inch.* | *Inch.* | |
| 2,000 | | —.50 | —.12 | |
| 4,000 | | —.45 | —.12 | |
| 6,000 | | —.45 | —.12 | |
| 8,000 | | —.45 | —.12 | |
| 10,000 | | —.48 | —.12 | |
| 12,000 | | —.50 | —.17 | |
| 14,000 | | —.62 | —.19 | |
| 16,000 | | —.56 | —.20 | |
| 18,000 | | —.59 | —.22 | |
| 20,000 | | —.62 | —.25 | |
| 22,000 | | —.68 | —.23 | |
| 24,000 | | —.74 | —.30 | |
| 26,000 | | —.80 | —.32 | |
| 28,000 | | —.90 | —.37 | Figures below refer to this curved line: |
| 30,000 | | —1.00 | —.40 | |
| 31,000 | | —1.05 | —.45 | |
| 32,000 | | —1.13 | —.50 | |
| 33,000 | | —1.20 | —.53 | |
| 34,000 | | —1.30 | —.56 | |
| 35,000 | | —1.40 | —.60 | Shape of stick while under 38,000 pounds compression. Ordinates measured each 2 feet. |
| 36,000 | | —1.55 | —.66 | |
| 37,000 | | —1.70 | —.70 | 0, ″.28, ″.65, 1″.10, 1″.55, 1″.85, 2″.05, 2″.06, 1″.88, 1″.57, 1″.15, ″.70, ″.32, ″.15, ″.18, 0. |
| 38,000 | | —1.95 | —.79 | |
| 38,000 | | —2.18 | —.92 | |
| 49,000 | 1,383 | —2.70 | —1.07 | Ultimate strength. |

Failed by horizontal and downward deflection. Deflected suddenly when load reached its maximum, increasing to about 8″ horizontal and vertical at middle.

Posts of this length and diameter have changed from triple flexure when sudden springing occurred to single flexure, like a post with pin ends.

No. 501.



Sectional area, 28.1 square inches.

Weight, 256 pounds.

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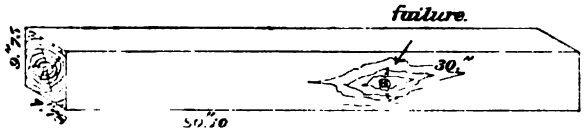
Counterweight at middle, 128 pounds.
Initial bend to stick before dressed down from size 6″×6″: Horizontal, —″.25; vertical, —″.30.

| Loads applied. | Pounds per square inch. | Deflections. Horizontal. | Deflections. Vertical. | Remarks. |
|---|---|---|---|---|
| *Pounds.* | | *Inch.* | *Inch.* | |
| 2,000 | | —.27 | —.40 | |
| 4,000 | | —.27 | —.22 | |
| 6,000 | | —.26 | —.09 | |
| 8,000 | | —.27 | —.04 | |
| 10,000 | | —.28 | —.03 | |
| 12,000 | | —.29 | —.01 | |
| 14,000 | | —.30 | 0. | |
| 16,000 | | —.31 | .01 | |
| 18,000 | | —.32 | .02 | |
| 20,000 | | —.35 | .04 | |
| 22,000 | | —.38 | .05 | |
| 24,000 | | —.38 | .06 | |
| 26,000 | | —.42 | .07 | |
| 28,000 | | —.47 | .08 | |
| 30,000 | | —.51 | .10 | |
| 32,000 | | —.56 | .11 | |
| 34,000 | | —.65 | .12 | |
| 36,000 | | —.75 | .15 | |
| 38,000 | | —.90 | .16 | |
| 40,000 | | —1.10 | .20 | |
| 42,000 | | —1.40 | .26 | |
| 43,000 | | —1.70 | .32 | |
| 44,000 | | —2.10 | .42 | |
| 44,400 | 1,580 | | | Ultimate strength. |

Failed by deflection sideways and upward, springing suddenly soon after passing the maximum load, increasing the deflections to about —8″ horizontal, 2″ vertical.

No. 572.




Sectional area, 75.8 square inches.
Weight, 124 pounds.
Gauged length, 50″.
Not counterweighted.
Average growth, 6 rings per inch.

| Loads applied. | Pounds per square inch. | Compression. | Permanent set. | Remarks. |
|---|---|---|---|---|
| *Pounds.* | | *Inch.* | *Inch.* | |
| 7,580 | 100 | 0. | | |
| 37,900 | 500 | .0210 | | |
| | 100 | | .0004 | |
| 75,800 | 1,000 | .0460 | | |
| | 100 | | .0011 | |
| 113,700 | 1,500 | .0716 | | |
| | 100 | | .0029 | |
| 151,600 | 2,000 | .0994 | | |
| | 100 | | .0055 | |
| 260,000 | 3,430 | | | Ultimate strength. |

Failed at a knot 2″ diameter, 30″ from end of post.

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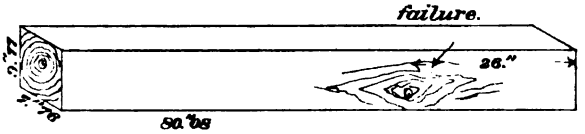
No. 573.

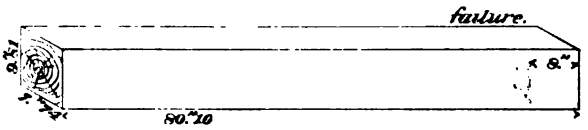



Sectional area, 75.8 square inches.
Weight, 131 pounds.
Gauged length, 50″.
Not counterweighted.
Average rate of growth, 14 rings per inch.

| Loads applied. | Pounds per square inch. | Compression. | Permanent set. | Remarks. |
|---|---|---|---|---|
| *Pounds.* | | *Inch.* | *Inch.* | |
| 7,580 | 100 | 0. | | |
| 37,900 | 500 | .0113 | | |
| | 100 | | 0. | |
| 75,800 | 1,000 | .0270 | | |
| | 100 | | .0005 | |
| 113,700 | 1,500 | .0436 | | |
| | 100 | | .0009 | |
| 151,600 | 2,000 | .0595 | | |
| | 100 | | .0012 | |
| 286,500 | 3,780 | | | Ultimate strength. |

Failed by crushing fibers at a knot 26″ from end of post.

No. 574.




Sectional area, 75.9 square inches.
Weight, 161½ pounds.
Gauged length, 50″.
Not counterweighted.
Average rate of growth, 21 rings per inch.

| Loads applied. | Pounds per square inch. | Compression. | Permanent set. | Remarks. |
|---|---|---|---|---|
| *Pounds.* | | *Inch.* | *Inch.* | |
| 7,590 | 100 | 0. | | |
| 37,950 | 500 | .0110 | | |
| | 100 | | 0. | |
| 75,900 | 1,000 | .0245 | | |
| 100 | | | .0003 | |
| 113,850 | 1,500 | .0390 | | |
| | 100 | | .0008 | |
| 151,800 | 2,000 | .0530 | | |
| | 100 | | .0010 | |
| 383,000 | | | | Ultimate strength. |

Fibers crushed about 8″ from end, in the vicinity of knots.

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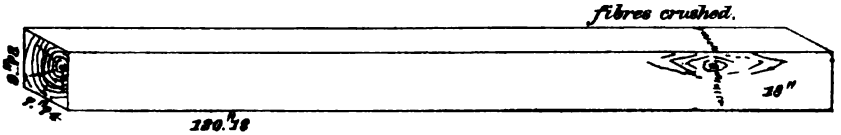
No. 578.

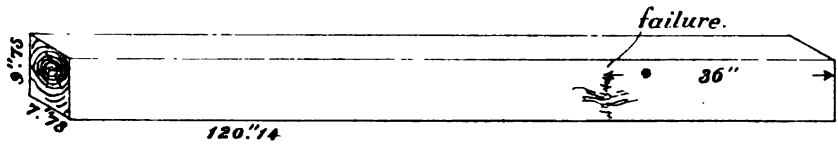



Sectional area, 75.3 square inches.
Weight, 233½ pounds.
Gauged length, 100″.
Not counterweighted.
Average rate of growth, 23 rings per inch.

| Loads applied. | Pounds per square inch. | Compression. | Permanent set. | Remarks. |
|---|---|---|---|---|
| *Pounds.* | | *Inch.* | *Inch.* | |
| 7,530 | 100 | 0. | | |
| 37,650 | 500 | .0230 | | |
| | 100 | | .0007 | |
| 75,300 | 1,000 | .0530 | | |
| | 100 | | .0011 | |
| 112,950 | 1,500 | .0830 | | |
| | 100 | | .0018 | |
| 150,600 | 2,000 | .1147 | | |
| | 100 | | .0027 | |
| 304,000 | 4,037 | | | Ultimate strength. |

Failed at a knot 18″ from end of post.

No. 579.




Sectional area, 75.9 square inches.
Weight, 240 pounds.
Gauged length, 100″.
Not counterweighted.
Average growth, 19 rings per inch.

| Loads applied. | Pounds per square inch. | Compression. | Permanent set. | Remarks. |
|---|---|---|---|---|
| *Pounds.* | | *Inch.* | *Inch.* | |
| 7,590 | 100 | 0. | | |
| 37,950 | 500 | .0160 | | |
| | 100 | | .0005 | |
| 75,900 | 1,000 | .0375 | | |
| | 100 | | .0008 | |
| 113,850 | 1,500 | .0604 | | |
| | 100 | | .0010 | |
| 151,800 | 2,000 | .0840 | | |
| | 100 | | .0010 | |
| 399,500 | 5,264 | | | Ultimate strength. |

Crushed fibers 36″ from end. Grain of the wood wavy at this place.

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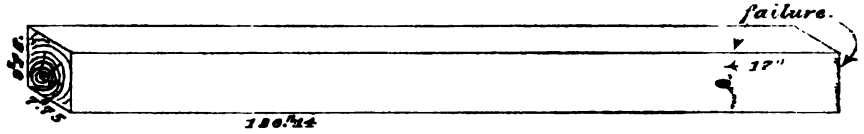
No. 580.

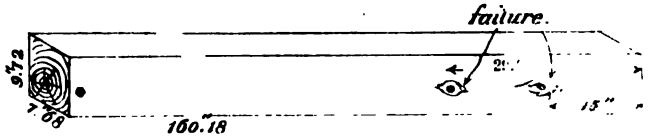



Sectional area, 75.6 square inches.
Weight, 240 pounds.
Gauged length, 100″.
Not counterweighted.
Average rate of growth, 28 rings per inch.

| Loads applied. | Pounds per square inch. | Compression. | Permanent set. | Remarks. |
|---|---|---|---|---|
| *Pounds.* | | *Inch.* | *Inch.* | |
| 7,560 | 100 | 0. | | |
| 37,800 | 500 | .0175 | | |
| | 100 | | 0. | |
| 75,600 | 1,000 | .0415 | | |
| | 100 | | 0. | |
| 113,400 | 1,500 | .0663 | | |
| | 100 | | 0. | |
| 151,200 | 2,000 | .0913 | | |
| | 100 | | 0. | |
| 350,000 | 4,629 | | | Ultimate strength. |

Crushed fibers at end of post and at knot 17″ from end.

No. 584.




Sectional area, 74.6 square inches.
Weight, 266 pounds.
Gauged length, 100″.
Not counterweighted.
Average rate of growth, 18 rings per inch.

| Loads applied. | Pounds per square inch. | Compression. | Permanent set. | Remarks. |
|---|---|---|---|---|
| *Pounds.* | | *Inch.* | *Inch.* | |
| 7,460 | 100 | 0. | | |
| 37,300 | 500 | .0182 | | |
| | 100 | | .0010 | |
| 74,600 | 1,000 | .0465 | | |
| | 100 | | .0017 | |
| 111,900 | 1,500 | .0758 | | |
| | 100 | | | |
| 149,200 | 2,000 | .1080 | | |
| | 100 | | .0035 | |
| 307,500 | 4,122 | | | Ultimate strength. |

Failed at knots 15″ and 29″ from end.

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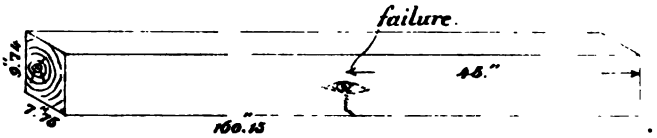
No. 585.

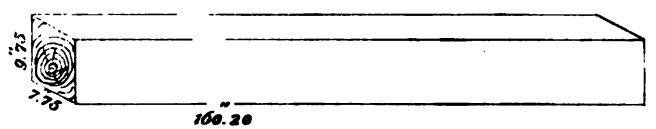



Sectional area, 75.5 square inches.
Gauged length, 100″.
Weight, 258 pounds.
Not counterweighted.
Average rate of growth, 6 rings per inch.

| Loads applied. | Pounds per square inch. | Compression. | Permanent set. | Remarks. |
|---|---|---|---|---|
| *Pounds.* | | *Inch.* | *Inch.* | |
| 7,550 | 100 | 0. | | |
| 37,750 | 500 | .0287 | | |
| | 100 | | 0. | |
| 75,500 | 1,000 | .0700 | | |
| | 100 | | .0006 | |
| 113,250 | 1,500 | .1135 | | |
| | 100 | | .0025 | |
| 151,000 | 2,000 | .1600 | | |
| | 100 | | .0061 | |
| 284,000 | 3,762 | | | Ultimate strength. |

Fibers crushed at knots 45″ from end and near the middle.
Post deflecting downward.

No. 586.




Sectional area, 75.5 square inches.
Weight, 336 pounds.
Gauged length, 100″.
Not counterweighted.
Average rate of growth, 23 rings per inch.

| Loads applied. | Pounds per square inch. | Compression. | Permanent set. | Remarks. |
|---|---|---|---|---|
| *Pounds.* | | *Inch.* | *Inch.* | |
| 7,560 | 100 | 0. | | |
| 37,800 | 500 | .0220 | | |
| | 100 | | 0. | |
| 75,600 | 1,000 | .0525 | | |
| | 100 | | .0002 | |
| 113,400 | 1,500 | .0835 | | |
| | 100 | | .0008 | |
| 151,200 | 2,000 | .1150 | | |
| | 100 | | .0015 | |
| 296,000 | 3,921 | | | Ultimate strength. |

Fibers crushed at knot near middle of post.

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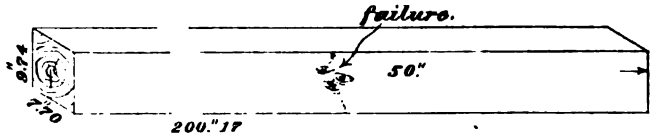
No. 587.

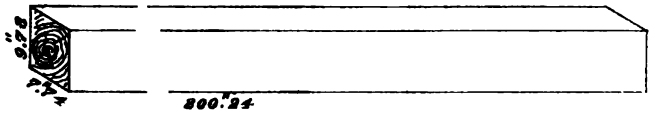



Sectional area, 75 square inches.
Gauged length, 150″.
Weight, 318 pounds.
Counterweight at middle, 158 pounds.
Average rate of growth, 24 rings per inch.

| Loads applied. | Pounds per square inch. | Compression. | Permanent set. | Deflections. Horizontal. | Deflections. Vertical. | Remarks. |
|---|---|---|---|---|---|---|
| *Pounds.* | | *Inch.* | *Inch.* | *Inch.* | *Inch.* | |
| 7,500 | 100 | 0. | ..... | 0. | 0. | |
| 37,500 | 500 | .0375 | ..... | 0. | .05 | |
| ..... | 100 | ..... | 0. | 0. | 0. | |
| 75,000 | 1,000 | .0900 | ..... | 0. | .06 | |
| ..... | 100 | ..... | 0. | 0. | 0. | |
| 112,500 | 1,500 | .1450 | ..... | 0. | .08 | |
| ..... | 100 | ..... | .0020 | 0. | 0. | |
| 150,000 | 2,000 | .2015 | ..... | 0. | .11 | |
| ..... | 100 | ..... | .0055 | 0. | .01 | |
| 200,000 | ..... | ..... | ..... | 0. | .17 | |
| 250,000 | ..... | ..... | ..... | .10 | .20 | |
| 74,500 | 3,660 | ..... | ..... | .70 | .25 | Ultimate strength. |

Failed at a group of knots 50″ from end, maximum deflection at this point.

No. 588.




Sectional area, 75.3 square inches.
Gauged length, 150″.
Weight, 381 pounds.
Counterweight at middle, 190 pounds.
Average rate of growth, 12 rings per inch.

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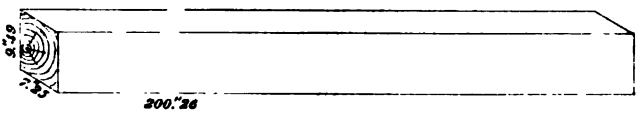
| Loads applied. | Pounds per square inch. | Compression. | Permanent set. | Deflections. | | Remarks. |
|---|---|---|---|---|---|---|
| | | | | Horizontal. | Vertical. | |
| *Pounds.* | | *Inch.* | *Inch.* | *Inch.* | *Inch.* | |
| 7,530 | 100 | 0. | | 0. | 0. | This post is free from knots; straight grain. |
| 37,650 | 500 | .0330 | | 0. | — .02 | |
| | 100 | | .0011 | 0. | 0. | |
| 75,300 | 1,000 | .0730 | | 0. | — .04 | |
| | 100 | | .0020 | 0. | 0. | |
| 112,950 | 1,500 | .1125 | | 0. | — .07 | |
| | 100 | | .0030 | 0. | 0. | |
| 150,600 | 2,000 | .1520 | | 0. | — .07 | |
| | 100 | | .0040 | 0. | 0. | |
| 200,000 | | | | .02 | — .09 | |
| 250,000 | | | | .04 | — .10 | |
| 300,000 | | | | .08 | — .12 | |
| 350,000 | | | | .15 | — .17 | |
| 382,000 | 5,073 | | | | | Ultimate strength. |

Failed by deflecting sideways.

No. 589.

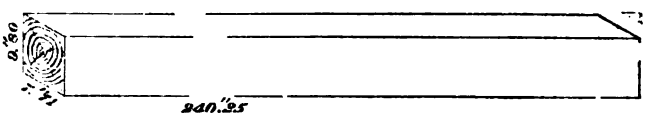



Sectional area, 68.8 square inches.
Gauged length, 150″.
Weight, 339½ pounds.
Counterweight at middle, 170 pounds.
Average rate of growth, 21 rings per inch.

| Loads applied. | Pounds per square inch. | Compression. | Permanent set. | Deflections. | | Remarks. |
|---|---|---|---|---|---|---|
| | | | | Horizontal. | Vertical. | |
| *Pounds.* | | *Inch.* | *Inch.* | *Inch.* | *Inch.* | |
| 6,880 | 100 | 0. | | 0. | 0. | Season cracks in post running diagonally. |
| 34,400 | 500 | .0365 | | 0. | 0. | |
| | 100 | | .0016 | 0. | 0. | |
| 68,800 | 1,000 | .0800 | | .01 | .03 | |
| | 100 | | .0025 | 0. | 0. | |
| 103,200 | 1,500 | .1240 | | .03 | .06 | |
| | 100. | | .0035 | 0. | 0. | |
| 137,600 | 2,000 | .1688 | | .04 | .10 | |
| | 100 | | .0050 | 0. | 0. | |
| 250,000 | | | | .08 | .20 | |
| 300,000 | | | | — .15 | .24 | |
| 304,000 | 4,419 | | | — .50 | .23 | Ultimate strength. |

Failed by deflecting sideways.

No. 530.




Sectional area, 75.6 square inches.
Gauged length, 200″.



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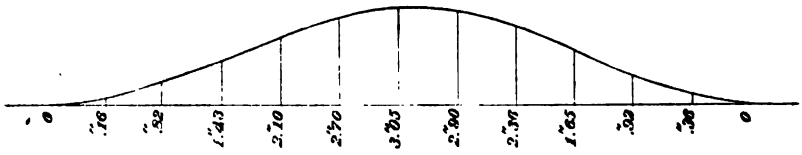
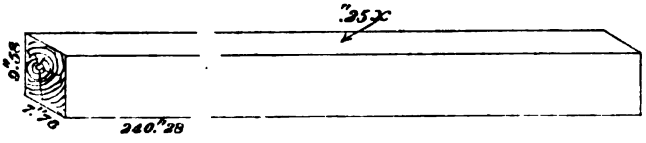
Weight, 461 pounds.
Counterweight at middle, 225 pounds.
Straight-grained, free from knots.

| Loads applied. | Pounds per square inch. | Compression. | Permanent set. | Deflections. | | Remarks. |
|---|---|---|---|---|---|---|
| | | | | Horizontal. | Vertical. | |
| *Pounds.* | | *Inch.* | *Inch.* | *Inch.* | *Inch.* | |
| 7,560 | 100 | 0. | ..... | 0. | 0. | |
| 37,800 | 500 | .0422 | ..... | .01 | .01 | |
| ..... | 100 | ..... | 0. | 0. | 0. | |
| 75,600 | 1,000 | .0958 | ..... | .04 | .03 | |
| ..... | 100 | ..... | .0009 | 0. | 0. | |
| 113,400 | 1,500 | .1515 | ..... | .09 | .05 | |
| ..... | 100 | ..... | .0012 | 0. | 0. | |
| 151,200 | 2,000 | ..... | ..... | .14 | .07 | |
| 160,000 | ..... | ..... | ..... | .15 | .08 | |
| 170,000 | ..... | ..... | ..... | .17 | .10 | |
| 180,000 | ..... | ..... | ..... | .19 | .10 | |
| 189,000 | 2,500 | ..... | ..... | .20 | .10 | |
| 200,000 | ..... | ..... | ..... | .22 | .11 | |
| 210,000 | ..... | ..... | ..... | .25 | .12 | |
| 220,000 | ..... | ..... | ..... | .28 | .12 | |
| 230,000 | ..... | ..... | ..... | .32 | .13 | |
| 240,000 | ..... | ..... | ..... | .35 | .14 | |
| 250,000 | ..... | ..... | ..... | .41 | .15 | |
| 260,000 | ..... | ..... | ..... | .49 | .16 | |
| 270,000 | ..... | ..... | ..... | .65 | .19 | |
| 280,000 | ..... | ..... | ..... | .95 | .24 | |
| 287,000 | 3,796 | ..... | ..... | 1.60 | .24 | Ultimate strength. |

Failed by horizontal deflection.
Strains continued, increasing the deflection to 3″.05 at middle. Ordinates now measured each 20″ to show the curve of flexure.




No. 531.




Sectional area, 74.3 square inches.
Gauged length, 200″.
Weight, 410 pounds.
Counterweight at middle, 225 pounds.
Post has 18 knots from $\frac{3}{4}$″ to 2″ diameter. Initial bend in stick before dressing down from size 8″ × 10″: Vertical, +″.25.

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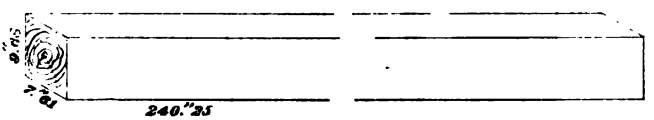
| Loads applied. | Pounds per square inch. | Compression. | Permanent set. | Deflections. | | Remarks. |
|---|---|---|---|---|---|---|
| | | | | Horizontal. | Vertical. | |
| *Pounds.* | | *Inch.* | *Inch.* | *Inch.* | *Inch.* | |
| 7,430 | 100 | 0. | ..... | 0. | 0. | |
| 37,150 | 500 | .0510 | ..... | 0. | —.03 | |
| ..... | 100 | ..... | .0005 | 0. | 0. | |
| 74,300 | 1,000 | .1095 | ..... | .01 | —.04 | |
| ..... | 100 | ..... | .0010 | 0. | 0. | |
| 111,450 | 1,500 | .1692 | ..... | .02 | —.06 | |
| ..... | 100 | ..... | .0027 | 0. | 0. | |
| 148,600 | 2,000 | .2300 | ..... | .03 | —.06 | |
| ..... | 100 | ..... | .0038 | 0. | 0. | |
| 160,000 | ..... | ..... | ..... | .03 | —.06 | |
| 170,000 | ..... | ..... | ..... | .04 | —.06 | |
| 180,000 | ..... | ..... | ..... | .04 | —.07 | |
| 190,000 | ..... | ..... | ..... | .04 | —.07 | |
| 200,000 | ..... | ..... | ..... | .04 | —.08 | |
| 210,000 | ..... | ..... | ..... | .05 | —.09 | |
| 220,000 | ..... | ..... | ..... | .05 | —.09 | |
| 230,000 | ..... | ..... | ..... | .07 | —.10 | |
| 240,000 | ..... | ..... | ..... | .09 | —.10 | |
| 250,000 | ..... | ..... | ..... | .12 | —.12 | |
| 260,000 | ..... | ..... | ..... | .18 | —.15 | |
| 270,000 | ..... | ..... | ..... | .32 | —.20 | |
| 275,000 | 3,701 | ..... | ..... | .82 | —.24 | Ultimate strength. |

Failed at some knots 70″ from the end. Maximum deflection developed at this point.

No. 532.




Sectional area, 73.7 square inches.
Gauged length, 200″.
Weight, 391 pounds.
Counterweight at middle, 225 pounds.
Post ¾″ winding before dressing down from size 8″×10″.
Cross-grained stick; season cracks take diagonal direction.

| Loads applied. | Pounds per square inch. | Compression. | Permanent set. | Deflection. | | Remarks. |
|---|---|---|---|---|---|---|
| | | | | Horizontal. | Vertical. | |
| *Pounds.* | | *Inch.* | *Inch.* | *Inch.* | *Inch.* | |
| 7,370 | 100 | 0. | ..... | 0. | 0. | |
| 36,850 | 500 | .0515 | ..... | —.02 | .04 | |
| ..... | 100 | ..... | 0. | 0. | 0. | |
| 73,700 | 1,000 | .1190 | ..... | —.06 | .10 | |
| ..... | 100 | ..... | .0005 | 0. | 0. | |
| 110,550 | 1,500 | .1865 | ..... | —.10 | .16 | |
| ..... | 100 | ..... | .0010 | 0. | 0. | |
| 147,400 | 2,000 | ..... | ..... | —.19 | .25 | |
| 160,000 | ..... | ..... | ..... | —.22 | .29 | |
| 170,000 | ..... | ..... | ..... | — 26 | .31 | |
| 180,000 | ..... | ..... | ..... | —.32 | .35 | |
| 190,000 | ..... | ..... | ..... | —.36 | .40 | |
| 200,000 | ..... | ..... | ..... | —.48 | .43 | |
| 210,000 | ..... | ..... | ..... | —.66 | .48 | |
| 220,000 | 2,985 | ..... | ..... | —1.08 | .54 | Ultimate strength. |

Failed by horizontal and vertical deflection.

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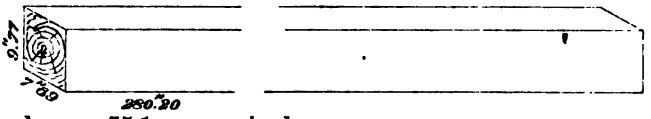
No. 542.

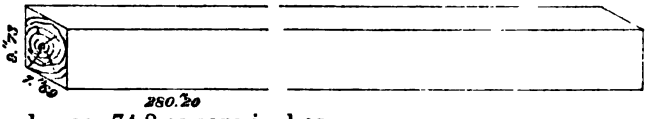


Sectional area, 75.1 square inches.
Gauged length, 200″.
Weight, 501 pounds.
Counterweight at middle, 250 pounds.

| Loads applied. | Pounds per square inch. | Compression. | Permanent set. | Deflection. | | Remarks. |
|---|---|---|---|---|---|---|
| | | | | Horizontal. | Vertical. | |
| *Pounds.* | | *Inch.* | *Inch.* | *Inch.* | *Inch.* | |
| 7,510 | 100 | 0. | ..... | 0. | 0. | |
| 37,550 | 500 | .0490 | ..... | —.01 | 0. | |
| ..... | 100 | ..... | 0. | 0. | 0. | |
| 75,100 | 1,000 | .1088 | ..... | —.05 | 0. | |
| ..... | 100 | ..... | .0010 | 0. | 0. | |
| 112,650 | 1,500 | .1710 | ..... | —.09 | 0. | |
| ..... | 100 | ..... | .0030 | 0. | 0. | |
| 150,200 | 2,000 | .2332 | ..... | —.12 | .02 | |
| ..... | 100 | ..... | .0053 | 0. | 0. | |
| 160,000 | ..... | ..... | ..... | —.15 | .03 | |
| 170,000 | ..... | ..... | ..... | —.17 | .04 | |
| 180,000 | ..... | ..... | ..... | —.20 | .05 | |
| 190,000 | ..... | ..... | ..... | —.24 | .06 | |
| 200,000 | ..... | ..... | ..... | —.30 | .08 | |
| 210,000 | ..... | ..... | ..... | —.38 | .10 | |
| 220,000 | ..... | ..... | ..... | —.61 | .12 | |
| 225,000 | 2,996 | ..... | ..... | ..... | ..... | Ultimate strength. |

Failed rapidly by horizontal deflection when the maximum load was reached.

No. 543.



Sectional area, 74.8 square inches.
Gauged length, 200″.
Weight, 501 pounds.
Counterweight at middle, 250 pounds.

| Loads applied. | Pounds per square inch. | Compression. | Permanent set. | Deflections. | | Remarks. |
|---|---|---|---|---|---|---|
| | | | | Horizontal. | Vertical. | |
| *Pounds.* | | *Inch.* | *Inch.* | *Inch.* | *Inch.* | |
| 7,480 | 100 | 0. | ..... | 0. | 0. | |
| 37,400 | 500 | .0448 | ..... | .01 | .02 | |
| ..... | 100 | ..... | —.0005 | 0. | .01 | |
| 74,800 | 1,000 | .1040 | ..... | .06 | .04 | |
| ..... | 100 | ..... | 0. | 0. | .01 | |
| 112,200 | 1,500 | .1665 | ..... | .10 | .04 | |
| ..... | 100 | ..... | .0020 | 0. | .01 | |
| 149,600 | 2,000 | .2290 | ..... | .20 | .04 | |
| ..... | 100 | ..... | .0050 | .01 | .01 | |
| 160,000 | ..... | ..... | ..... | .22 | .05 | |
| 170,000 | ..... | ..... | ..... | .26 | .05 | |
| 180,000 | ..... | ..... | ..... | .31 | .06 | |
| 190,000 | ..... | ..... | ..... | .40 | .06 | |
| 200,000 | ..... | ..... | ..... | .50 | .07 | |
| 210,000 | ..... | ..... | ..... | .74 | .09 | |
| 220,000 | ..... | ..... | ..... | 1.60 | .13 | |
| 220,500 | 2,948 | ..... | ..... | 2.10 | .13 | Ultimate strength. |

Failed by horizontal deflection.

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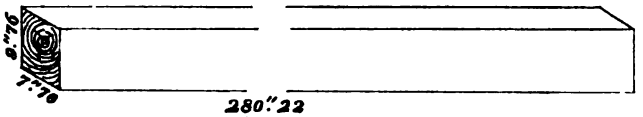
No. 544.

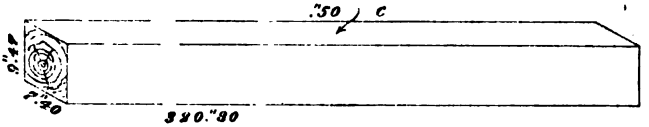



Sectional area, 75.1 square inches.
Gauged length, 200″.
Weight, 560 pounds.
Counterweight at middle, 280 pounds.

| Loads applied. | Pounds per square inch. | Compression. | Permanent set. | Deflections. | | Remarks. |
|---|---|---|---|---|---|---|
| | | | | Horizontal. | Vertical. | |
| *Pounds.* | | *Inch.* | *Inch.* | *Inch.* | *Inch.* | |
| 7,510 | 100 | 0. | | 0. | 0. | |
| 37,550 | 500 | .0412 | | 0. | —.05 | |
| | 100 | | 0. | 0. | 0. | |
| 75,100 | 1,000 | .0900 | | —.02 | —.08 | |
| | 100 | | .0004 | 0. | 0. | |
| 112,650 | 1,500 | .1400 | | —.05 | —.11 | |
| | 100 | | .0018 | 0. | 0. | |
| 150,200 | 2,000 | .1904 | | —.06 | —.16 | |
| | 100 | | .0030 | 0. | 0. | |
| 160,000 | | | | —.07 | —.16 | |
| 170,000 | | | | —.07 | —.18 | |
| 180,000 | | | | —.07 | —.19 | |
| 190,000 | | | | —.07 | —.20 | |
| 200,000 | | | | —.07 | —.20 | |
| 210,000 | | | | —.07 | —.21 | |
| 220,000 | | | | —.07 | —.22 | |
| 230,000 | | | | —.07 | —.23 | |
| 240,000 | | | | —.07 | —.24 | |
| 250,000 | | | | —.07 | —.25 | |
| 260,000 | | | | —.07 | —.26 | |
| 270,000 | | | | —.02 | —.27 | |
| 280,000 | | | | +.02 | —.29 | |
| 290,000 | | | | —.16 | —.30 | |
| 298,000 | 3,968 | | | | | Ultimate strength. |

Failed by deflecting sideways.

No. 527.




Sectional area, 70 square inches.
Weight, 531 pounds.
Gauged length, 300″.
Counterweight at middle, 300 pounds.
Initial deflection before stick was dressed down from 8″ × 10″: Vertical, — ″.50.

| Loads applied. | Pounds per square inch. | Compression. | Permanent set. | Deflections. | | Remarks. |
|---|---|---|---|---|---|---|
| | | | | Horizontal. | Vertical. | |
| *Pounds.* | | *Inch.* | *Inch.* | *Inch.* | *Inch.* | |
| 7,000 | 100 | 0. | | 0. | 0. | |
| 35,000 | 500 | .0625 | | —.02 | —.02 | |
| | 100 | | 0. | 0. | 0. | |
| 70,000 | 1,000 | .1428 | | —.07 | —.10 | |
| | 100 | | .0068 | 0. | 0. | |
| 105,000 | 1,500 | .2218 | | —.10 | —.16 | |
| | 100 | | .0012 | 0. | 0. | |
| 140,000 | 2,000 | | | —.11 | —.23 | |
| 210,000 | 3,000 | | | —.99 | —.50 | Ultimate strength. |

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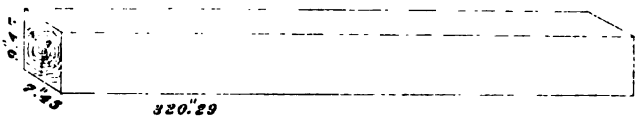
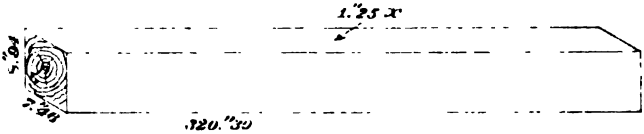
No. 528.



Sectional area, 70.4 square inches.
Weight, 627 pounds.
Counterweight at middle, 300 pounds.
Gauged length, 300″.

| Loads applied. | Pounds per square inch. | Compression. | Permanent set. | Deflections. | | Remarks. |
|---|---|---|---|---|---|---|
| | | | | Horizontal. | Vertical. | |
| *Pounds.* | | *Inch.* | *Inch.* | *Inch.* | *Inch.* | |
| 7,140 | 101 | 0. | | 0. | 0. | |
| 35,700 | 507 | .0593 | | −.05 | −.08 | |
| | 101 | | 0. | 0. | 0. | |
| 71,400 | 1,014 | .1360 | | −.10 | −.09 | |
| | 101 | | .0015 | 0. | 0. | |
| 107,100 | 1,521 | .2170 | | −.18 | −.14 | |
| | 101 | | .0030 | 0. | 0. | |
| 142,800 | 2,028 | | | −.30 | −.18 | |
| 178,500 | 2,535 | | | −.60 | −.25 | |
| 205,000 | 2,912 | | | −2.55 | −.40 | Ultimate strength. |

No. 529.



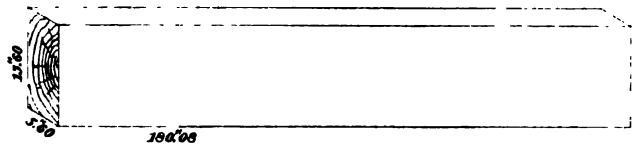
Sectional area, 66.7 square inches.
Weight, 535 pounds.
Counterweight at middle, 300 pounds.
Gauged length, 300″.
Initial deflection before stick was dressed down from size 8″ × 10″: Vertical, + 1″.25.

| Loads applied. | Pounds per square inch. | Compression. | Permanent set. | Deflections. | | Remarks. |
|---|---|---|---|---|---|---|
| | | | | Horizontal. | Vertical. | |
| *Pounds.* | | *Inch.* | *Inch.* | *Inch.* | *Inch.* | |
| 6,670 | 100 | 0. | | 0. | 0. | |
| 33,350 | 500 | .0680 | | .01 | 0. | |
| | 100 | | 0. | 0. | 0. | |
| 66,700 | 1,000 | .1588 | | .03 | −.09 | |
| | 100 | | 0. | 0. | 0. | |
| 100,050 | 1,500 | .2519 | | .07 | −.20 | |
| | 100 | | .0020 | 0. | 0. | |
| 133,400 | 2,000 | | | .08 | −.38 | |
| 140,000 | | | | .08 | −.45 | |
| 150,000 | | | | .10 | −.53 | |
| 160,000 | | | | .11 | −.70 | |
| 166,750 | 2,500 | | | .15 | −.80 | |
| 180,000 | | | | .38 | −1.15 | |
| 184,500 | 2,766 | | | Ab't 2.20 | Ab't −1.50 | Ultimate strength. |

Failed by deflecting sideways and downward.

Digitized by Google

No. 711.

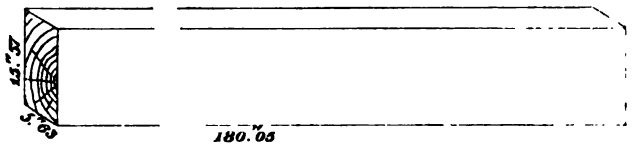



Sectional area, 87.4 square inches.
Gauged length, 150″.
Weight, 375 pounds.
Average rate of growth, 12 rings per inch.

| Loads applied. | Pounds per square inch. | Compression. | Permanent set. | Deflections. Horizontal. | Deflections. Vertical, W. | Deflections. Vertical, E. | Remarks. |
|---|---|---|---|---|---|---|---|
| *Pounds.* | | *Inch.* | *Inch.* | *Inch.* | *Inch.* | *Inch.* | |
| 0. | 0 | 0. | | 0. | 0. | 0. | |
| 43,700 | 500 | .0491 | | .03 | .01 | − .06 | |
| | 0 | | .0004 | | | | |
| 80,000 | | | | .03 | .02 | | |
| 100,000 | | | | .03 | .06 | − .10 | |
| 140,000 | | | | .03 | .09 | | |
| 180,000 | | | | .03 | .10 | | |
| 200,000 | | | | .03 | .12 | − .12 | |
| 220,000 | | | | .01 | .13 | | |
| 230,000 | | | | .01 | .14 | | |
| 240,000 | | | | 0. | .14 | | |
| 250,000 | | | | 0. | .14 | | |
| 260,000 | | | | 0. | .15 | | |
| 270,000 | | | | 0. | .15 | | |
| 280,000 | | | | − .01 | .15 | | |
| 290,000 | | | | − .01 | .16 | | |
| 300,000 | | | | − .02 | .16 | | |
| 310,000 | | | | − .05 | .17 | | |
| 320,000 | | | | − .07 | .19 | − .15 | |
| 330,000 | | | | − .11 | .20 | | |
| 340,000 | | | | − .20 | .20 | | |
| 349,000 | 3,993 | | | − .52 | .20 | | Ultimate strength. |

Failed by horizontal deflection, minus direction.

No. 712.



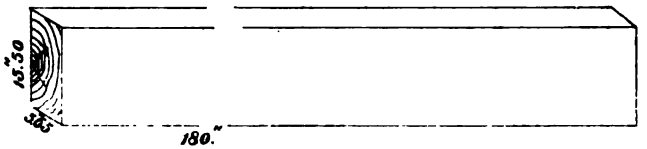

Sectional area, 87.7 square inches.
Gauged length, 150″.
Weight, 397 pounds.
Average rate of growth, 21 rings per inch.
Stick injured by wind-shakes.

Digitized by Google

| Loads applied. | Pounds per square inch. | Compression. | Permanent set. | Deflections. Horizontal. | Deflections. Vertical, W. | Deflections. Vertical, E. | Remarks. |
|---|---|---|---|---|---|---|---|
| *Pounds.* | | *Inch.* | *Inch.* | *Inch.* | *Inch.* | *Inch.* | |
| 0 | 0 | 0. | ..... | 0. | 0. | ..... | |
| 43,850 | 500 | .0370 | ..... | 0. | .06 | ..... | |
| ..... | 0 | ..... | 0. | ..... | ..... | ..... | |
| 80,000 | ..... | ..... | ..... | 0. | .08 | ..... | |
| 100,000 | ..... | ..... | ..... | −.01 | .10 | −.05 | |
| 140,000 | ..... | ..... | ..... | −.01 | .10 | ..... | |
| 180,000 | ..... | ..... | ..... | −.02 | .11 | ..... | |
| 200,000 | ..... | ..... | ..... | −.04 | .11 | −.05 | |
| 220,000 | ..... | ..... | ..... | −.05 | .12 | ..... | |
| 240,000 | ..... | ..... | ..... | −.05 | .12 | ..... | |
| 260,000 | ..... | ..... | ..... | −.06 | .12 | ..... | |
| 280,000 | ..... | ..... | ..... | −.10 | .13 | ..... | |
| 300,000 | ..... | ..... | ..... | −.11 | .14 | −.07 | |
| 310,000 | ..... | ..... | ..... | −.17 | .14 | ..... | |
| 320,000 | ..... | ..... | ..... | −.24 | .15 | ..... | |
| 330,000 | ..... | ..... | ..... | −.33 | .15 | ..... | |
| 339,000 | 3,865 | ..... | ..... | ..... | ..... | ..... | Ultimate strength. |

Failed by horizontal deflection, minus direction.

## No. 713.




Sectional area, 87.6 square inches.
Gauged length, 150″.
Weight, 382 pounds.
Average rate of growth, 15 rings per inch.

| Loads applied. | Pounds per square inch. | Compression. | Permanent set. | Deflections. Horizontal. | Deflections. Vertical, W. | Deflections. Vertical, E. | Remarks. |
|---|---|---|---|---|---|---|---|
| *Pounds.* | | *Inch.* | *Inch.* | *Inch.* | *Inch.* | *Inch.* | |
| 0 | 0 | 0. | ..... | 0. | 0. | 0. | |
| 43,800 | 500 | .0524 | ..... | −.13 | .01 | ..... | |
| ..... | 0 | ..... | .0006 | ..... | ..... | ..... | |
| 80,000 | ..... | ..... | ..... | −.15 | −.01 | ..... | |
| 100,000 | ..... | ..... | ..... | −.17 | −.02 | 0. | |
| 140,000 | ..... | ..... | ..... | −.21 | −.02 | ..... | |
| 180,000 | ..... | ..... | ..... | −.28 | −.02 | ..... | |
| 200,000 | ..... | ..... | ..... | −.31 | −.02 | .05 | |
| 220,000 | ..... | ..... | ..... | −.37 | −.02 | ..... | |
| 240,000 | ..... | ..... | ..... | −.43 | −.02 | ..... | |
| 250,000 | ..... | ..... | ..... | −.50 | −.02 | ..... | |
| 260,000 | ..... | ..... | ..... | −.61 | −.04 | ..... | |
| 270,000 | ..... | ..... | ..... | −.98 | −.08 | ..... | |
| 272,500 | 3,111 | ..... | ..... | −1.17 | ..... | ..... | Ultimate strength. |

Failed by horizontal deflection, minus direction.
Fibers crushed at a knot at middle of post.

Digitized by Google

No. 484.

Sectional area, end, 109.4 square inches.
Sectional area, middle, 111.3 square inches.
Gauged length, 160″.
Weight, 432 pounds.

| Loads applied. | Pounds per square inch. | Compression. | Permanent set. | Deflections. | | Remarks. |
|---|---|---|---|---|---|---|
| | | | | Horizontal. | Vertical. | |
| *Pounds.* | | *Inch.* | *Inch.* | *Inch.* | *Inch.* | |
| 10,000 | ..... | 0. | ..... | 0. | 0. | |
| 50,000 | ..... | .0380 | ..... | 0. | 0. | |
| 10,000 | ..... | ..... | .0005 | 0. | 0. | |
| 100,000 | ..... | .1080 | ..... | 0. | − .02 | |
| 10,000 | ..... | ..... | .0015 | 0. | 0. | |
| 150,000 | ..... | .1685 | ..... | + .02 | − .05 | |
| 10,000 | ..... | ..... | .0018 | 0. | 0. | |
| 180,000 | ..... | .2060 | ..... | .02 | − .05 | |
| 200,000 | ..... | .2332 | ..... | .02 | − .05 | Slight snapping sounds. |
| 10,000 | ..... | ..... | .0040 | 0. | 0. | |
| 220,000 | ..... | .2605 | ..... | .02 | − .07 | |
| 240,000 | ..... | .2910 | ..... | 0. | − .10 | |
| 260,000 | ..... | .3270 | ..... | − .08 | − .15 | |
| 270,000 | 2,468 | ..... | ..... | ..... | ..... | Ultimate strength. |

Sustained maximum load about one minute.

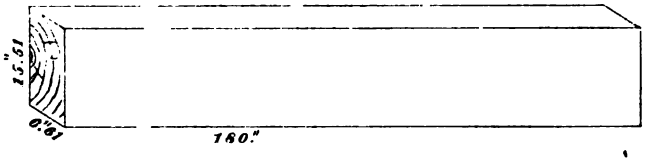
Failed by horizontal deflection. Concave side having large knot near the middle of the post, the heart being 2″ from concave side at one end; opposite end does not have heart in it.

The location of the heart was probably 2″ beyond edge of stick. Post was sawed obliquely with axis of tree running out 4″ in 15 feet; 150 rings of yearly growth in 10″.

Rapid growth during the first years; 6 rings in 1″ at center.

Time of test, one hour.

No. 708.



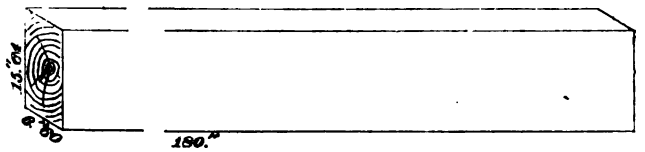

Sectional area, 102.5 square inches.
Gauged length, 150″.
Weight, 464 pounds.
Average rate of growth, 17 rings per inch.

Digitized by Google

| Loads applied. | Pounds per square inch. | Compression. | Permanent set. | Deflections. Horizontal. | Deflections. Vertical, W. | Deflections. Vertical, E. | Remarks. |
|---|---|---|---|---|---|---|---|
| *Pounds.* | | *Inch.* | *Inch.* | *Inch.* | *Inch.* | *Inch.* | |
| 0 | 0 | 0. | | 0. | 0. | 0. | |
| 51,250 | 500 | .0440 | | — .02 | 0. | | |
| | 0 | | .0005 | | | | |
| 80,000 | | | | — .02 | 0. | | |
| 100,000 | | | | — .02 | 0. | | |
| 140,000 | | | | — .06 | .01 | | |
| 180,000 | | | | — .08 | .01 | | |
| 200,000 | | | | — .10 | .02 | — .04 | |
| 240,000 | | | | — .13 | .02 | | |
| 260,000 | | | | — .16 | .02 | | |
| 280,000 | | | | — .20 | .02 | | |
| 300,000 | | | | — .26 | .02 | | |
| 320,000 | | | | — .38 | .02 | | |
| 340,000 | 3,317 | | | — .60 | .08 | | Ultimate strength. |

Failed at some knots at middle of post.

No. 709.




Sectional area, 103.2 square inches.
Gauged length, 150″.
Weight, 557 pounds.
Average rate of growth, 18 rings per inch.

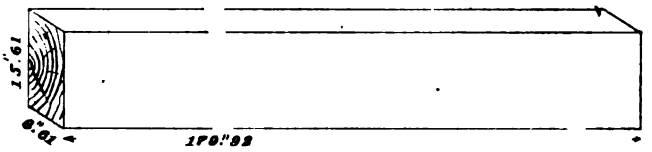
| Loads applied. | Pounds per square inch. | Compression. | Compression set. | Deflections. Horizontal. | Deflections. Vertical, W. | Deflections. Vertical, E. | Remarks. |
|---|---|---|---|---|---|---|---|
| *Pounds.* | | *Inch.* | *Inch.* | *Inch.* | *Inch.* | *Inch.* | |
| 0 | 0 | 0. | | 0. | 0. | 0. | |
| 51,600 | 500 | .0570 | | — .05 | — .09 | — .05 | |
| | 0 | | .0008 | | | | |
| 80,000 | | | | .05 | — .09 | | |
| 100,000 | | | | .05 | — .09 | | |
| 140,000 | | | | .04 | — .09 | | |
| 180,000 | | | | .03 | — .09 | | |
| 200,000 | | | | .02 | — .09 | | |
| 240,000 | | | | 0. | — .09 | | |
| 280,000 | | | | — .01 | — .09 | | |
| 300,000 | | | | — .02 | — .09 | — .10 | |
| 320,000 | | | | — .05 | — .09 | | |
| 330,000 | | | | — .05 | — .00 | | |
| 340,000 | | | | — .06 | — .09 | | |
| 350,000 | | | | — .07 | — .09 | | |
| 360,000 | | | | — .07 | — .09 | | |
| 370,000 | | | | — .08 | — .09 | | |
| 380,000 | | | | — .09 | — .09 | | |
| 390,000 | | | | — .11 | — .10 | | |
| 400,000 | | | | — .13 | — .10 | — .13 | |
| 410,000 | | | | — .15 | — .10 | | |
| 420,000 | | | | — .18 | — .10 | | |
| 430,000 | | | | — .21 | — .10 | | |
| 440,000 | | | | — .27 | — .10 | | |
| 450,000 | | | | — .40 | — .10 | | |
| 455,000 | 4,409 | | | — .62 | — .10 | | Ultimate strength. |

Digitized by Google

Failed by horizontal deflection, minus direction.

Horizontal deflection increased to —3″.30; fibers of stick crushed at 1″ to 6½″ from end. Grain straight.

No. 710.




Sectional area, 103.2 square inches.
Gauged length, 150″.
Weight, 491 pounds.
Average rate of growth, 18 rings per inch.

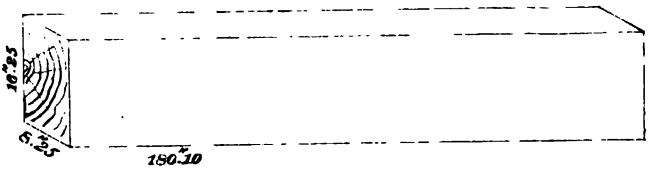
| Loads applied. | Pounds per square inch. | Compression. | Permanent set. | Deflections. | | | Remarks. |
|---|---|---|---|---|---|---|---|
| | | | | Horizontal. | Vertical, W. | Vertical, E. | |
| *Pounds.* | | *Inch.* | *Inch.* | *Inch.* | *Inch.* | *Inch.* | |
| 0 | 0 | 0. | | 0. | 0. | 0. | |
| 51,600 | 500 | .312 | | —.06 | .02 | | |
| | 0 | | 0. | | | | |
| 80,000 | | | | —.06 | .02 | | |
| 100,000 | | | | —.06 | .02 | | |
| 140,000 | | | | —.06 | .03 | | |
| 180,000 | | | | —.06 | .05 | | |
| 200,000 | | | | —.06 | .06 | 0. | |
| 240,000 | | | | —.06 | .07 | | |
| 280,000 | | | | —.07 | .08 | | |
| 300,000 | | | | —.08 | .08 | —.02 | |
| 340,000 | | | | —.09 | .09 | | |
| 360,000 | | | | —.10 | .09 | | |
| 380,000 | | | | —.11 | .09 | | |
| 400,000 | | | | —.16 | .10 | —.05 | |
| 420,000 | | | | —.26 | .10 | | |
| 430,000 | | | | —.37 | .11 | | |
| 432,000 | 4,186 | | | —.50* | | | Ultimate strength. |

*About.

Failed by horizontal deflection, minus direction.

Horizontal deflection increased to 3″.20, slightly crushing fibers 29″ from south end, where stick appeared weakened by shakes and seam cracks.

No. 641.



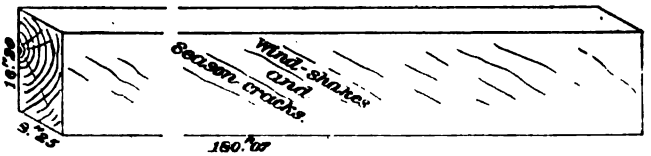

Sectional area, 134 square inches.
Weight, 561 pounds.
Gauged length, 150″.
Average rate of growth, 5 rings per inch.

Digitized by Google

| Loads applied. | Pounds per square inch. | Compression. | Permanent set. | Deflections. | | Remarks. |
|---|---|---|---|---|---|---|
| | | | | Horizontal. | Vertical. | |
| *Pounds.* | | *Inch.* | *Inch.* | *Inch.* | *Inch.* | |
| 13,400 | 100 | 0. | | 0. | 0. | |
| 67,000 | 500 | .0380 | | 0. | 0. | |
| 107,200 | 800 | .0663 | | 0. | .01 | |
| 134,000 | 1,000 | .0851 | | 0. | .01 | |
| | 100 | | 0. | 0. | 0. | |
| 150,000 | | | | 0. | .03 | |
| 160,000 | | | | 0. | .04 | |
| 170,000 | | | | 0. | .05 | |
| 180,000 | | | | 0. | .05 | |
| 200,000 | | | | 0. | .05 | |
| 220,000 | | | | 0. | .05 | |
| 240,000 | | | | 0. | .05 | |
| 260,000 | | | | 0. | .05 | |
| 280,000 | | | | 0. | .06 | |
| 300,000 | | | | 0. | .08 | |
| 320,000 | | | | 0. | .08 | |
| 340,000 | | | | .01 | .09 | |
| 360,000 | | | | .01 | .09 | |
| 380,000 | | | | .02 | .09 | |
| 400,000 | | | | .04 | .09 | |
| 410,000 | | | | .06 | .09 | |
| 420,000 | | | | .10 | .07 | |
| 425,000 | | | | .18 | .05 | |
| 428,000 | 3,194 | | | .18 | .02 | Ultimate strength. |

Failed by crushing fibers at middle and 40″ from end in the vicinity of knots.

No. 671.




Sectional area, 133 square inches.
Gauged length, 150″.
Weight, 585 pounds.
Average rate of growth, 12 rings per inch.

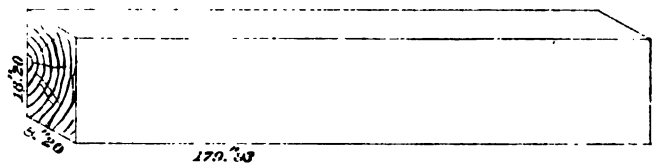
| Loads applied. | Pounds per square inch. | Compression. | Permanent set. | Deflections. | | | Remarks. |
|---|---|---|---|---|---|---|---|
| | | | | Horizontal. | Vertical, W. | Vertical, E. | |
| *Pounds.* | | *Inch.* | *Inch.* | *Inch.* | *Inch.* | *Inch.* | |
| 0 | 0 | 0. | | 0. | 0. | 0. | |
| 66,800 | 500 | .0612 | | — .01 | 0. | 0. | |
| | 0 | | .0006 | | | | |
| 80,000 | | | | — .01 | 0. | 0. | |
| 100,000 | | | | — .02 | .01 | .01 | |
| 140,000 | | | | — .02 | .01 | | |
| 160,000 | | | | — .03 | .02 | | |
| 200,000 | | | | — .04 | .03 | .01 | |
| 220,000 | | | | — .05 | .03 | | |
| 240,000 | | | | — .05 | .04 | | |
| 260,000 | | | | — .06 | .05 | | |
| 280,000 | | | | — .07 | .05 | | |
| 300,000 | | | | — .07 | .05 | .01 | |
| 320,000 | | | | — .08 | .06 | | |
| 340,000 | | | | — .09 | .06 | | |
| 360,000 | | | | — .11 | .06 | | |
| 380,000 | | | | — .15 | .07 | | |
| 400,000 | | | | — .20 | .08 | .01 | |
| 420,000 | | | | — .40 | .08 | | |
| 425,000 | 3,181 | | | — .88 | .08 | | Ultimate strength. |

Digitized by Google

Failed by horizontal deflection, minus direction.

When horizontal deflection had reached about —1″.35, a chalk-line was laid off on stick and ordinates measured every 12″, showing the curve of flexure as per the following sketch:

No. 672.



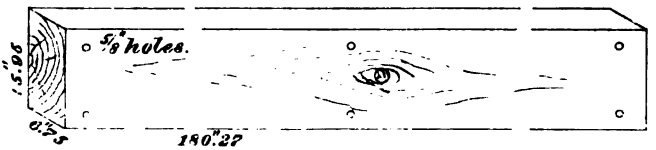

Sectional area, 132.8 square inches.
Gauged length, 150″.
Weight, 578 pounds.
Average rate of growth, 13 rings per inch.

| Loads applied. | Pounds per square inch. | Compression. | Permanent set. | Deflections. | | | Remarks. |
|---|---|---|---|---|---|---|---|
| | | | | Horizontal. | Vertical, W. | Vertical, E. | |
| *Pounds.* | | *Inch.* | *Inch.* | *Inch.* | *Inch.* | *Inch.* | |
| 0 | 0 | 0. | | 0. | 0. | 0. | |
| 66,400 | 500 | .0535 | | — .01 | 0. | | |
| 0 | 0 | | 0. | | | | |
| 80,000 | | | | — .01 | 0. | | |
| 100,000 | | | | — .01 | 0. | | |
| 140,000 | | | | — .01 | 0. | | |
| 180,000 | | | | — .01 | 0. | | |
| 200,000 | | | | — .01 | 0. | — .02 | |
| 240,000 | | | | — .01 | 0. | | |
| 260,000 | | | | — .01 | 0. | | |
| 280,000 | | | | — .02 | 0. | | |
| 300,000 | | | | — .03 | 0. | — .04 | |
| 320,000 | | | | — .03 | 0. | | |
| 340,000 | | | | — .03 | 0. | | |
| 360,000 | | | | — .03 | 0. | | |
| 380,000 | | | | — .03 | 0. | | |
| 400,000 | | | | — .04 | — .01 | — .07 | |
| 410,000 | | | | — .05 | — .01 | | |
| 420,000 | | | | — .05 | — .02 | | |
| 430,000 | | | | — .05 | — .02 | | |
| 440,000 | | | | — .05 | — .03 | | |
| 450,000 | | | | — .05 | — .03 | | |
| 460,000 | | | | — .05 | — .03 | | |
| 470,000 | | | | — .05 | — .05 | | |
| 480,000 | | | | — .05 | — .06 | | |
| 490,000 | | | | — .04 | — .07 | | |
| 500,000 | | | | — .03 | — .09 | — .17 | |
| 510,000 | | | | — .01 | — .11 | | |
| 520,000 | | | | + .01 | — .15 | | |
| 526,000 | 2,961 | | | .25 | — .20 | | Ultimate strength. |

Failed by horizontal deflection, plus direction.

Digitized by Google

No. 485.

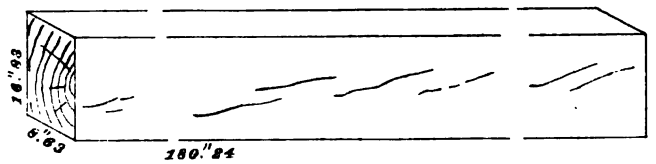



Sectional area, 107.7 square inches.
Weight, 434 pounds.
This stick taken from built post No. 691, which was tested March 11, 1881. It failed at the knot near middle in the original test, under 3,070 pounds per square inch compression.
The test was discontinued soon as the maximum load was passed, and the stick placed in the storehouse to season. Allowed to season thirteen months and then tested.

| Loads applied. | Pounds per square inch. | Compression. | Permanent set. | Deflections. | | Remarks. |
|---|---|---|---|---|---|---|
| | | | | Horizontal. | Vertical. | |
| *Pounds.* | | *Inch.* | *Inch.* | *Inch.* | *Inch.* | |
| 10,000 | | | | 0. | 0. | |
| 50,000 | | | | .05 | .02 | |
| 100,000 | | | | .40 | 0. | |
| 120,000 | | | | .62 | 0. | |
| 120,000 | | | | .70 | 0. | Sustained load 5 minutes. |
| 130,000 | | | | .80 | 0. | |
| 130,000 | | | | .90 | 0. | Sustained load 5 minutes. |
| 140,000 | | | | .92 | 0. | |
| 140.000 | | | | 1.00 | 0. | Sustained load 3 minutes. |
| 150,000 | | | | 1.10 | 0. | |
| 150,000 | | | | 1.23 | 0. | Sustained load 5 minutes. |
| 160,000 | | | | 1.35 | 0. | |
| 160,000 | | | | 1.50 | 0. | Sustained load 5 minutes. |
| 165,000 | | | | 1.56 | 0. | |
| 170,000 | | | | 1.70 | 0. | |
| 175,000 | 1,625 | | | 1.90 | | Ultimate strength. |

Sustained maximum load momentarily.
Failed by horizontal deflection; concave on the side having the knot.
Fibers crushed at middle knot and opened longitudinal crack.
Time of test three-quarters of an hour.

No. 486.




Sectional area, 145.2 square inches.
Gauged length, 160″.
Weight, 705 pounds.
Second test of post No. 714. Ultimate strength found by the first test, 456,000 pounds=3,180 pounds per square inch.
Rested in storehouse thirteen months, and again tested.
Grain of specimen oblique to axis.
Post free from knots.

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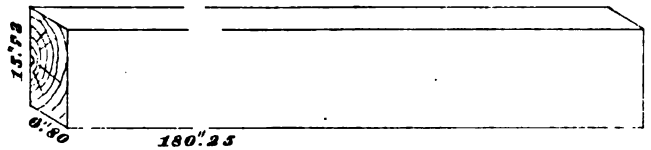
| Loads applied. | Pounds per square inch. | Compression. | Permanent set. | Deflections. | | Remarks. |
|---|---|---|---|---|---|---|
| | | | | Horizontal. | Vertical. | |
| *Pounds.* | | *Inch.* | *Inch.* | *Inch.* | *Inch.* | |
| 10,000 | | 0. | | 0. | 0. | |
| 50,000 | | .0265 | | 0. | + .02 | |
| 10,000 | | | 0. | 0. | 0. | |
| 100,000 | | .0640 | | 0. | .10 | |
| 10,000 | | | .0010 | 0. | 0. | |
| 200,000 | | .1520 | | 0. | .25 | Snapping sounds heard. |
| 10,000 | | | .0080 | 0. | 0. | |
| 220,000 | | | | 0. | .30 | |
| 240,000 | | | | 0. | .30 | |
| 260,000 | | | | 0. | .35 | |
| 280,000 | | | | 0. | .40 | |
| 300,000 | | | | 0. | .46 | |
| 300,000 | | | | 0. | .50 | Sustained load 5 minutes. |
| 320,000 | | | | 0. | .55 | |
| 340,000 | | | | 0. | .65 | |
| 340,000 | | | | 0. | .70 | Sustained load 3 minutes. |
| 360,000 | | | | 0. | .75 | |
| 380,000 | 2,617 | | | 0. | .85 | Ultimate strength. |

Sustained maximum load momentarily, then opened cracks rapidly as the pressure was gradually allowed to fall.

The longitudinal cracks were oblique with axis of post at an angle of about 5°.

The development of the cracks began at 200,000 pounds.

No. 487.




Sectional area, 106.9 square inches.

Gauged length, 160″.

Weight, 450 pounds.

Initial bend, ″.44; 1 sine.

Post free from knots.

This post was tested March 11, 1881, at that time sustaining 317,000 pounds = 2,795 pounds per square inch.

Second test made after rest of thirteen months nine days.

| Loads applied. | Pounds per square inch. | Compression. | Permanent set. | Deflections. | | Remarks. |
|---|---|---|---|---|---|---|
| | | | | Horizontal. | Vertical. | |
| *Pounds.* | | *Inch.* | *Inch.* | *Inch.* | *Inch.* | |
| 10,000 | | 0. | | 0. | 0. | |
| 50,000 | | .0282 | | 0. | 0. | |
| 10,000 | | | 0. | 0. | 0. | |
| 100,000 | | .0690 | | − .10 | 0. | |
| 10,000 | | | .0015 | 0. | 0. | |
| 150,000 | | .1120 | | − .20 | 0. | |
| 10,000 | | | .0040 | − .04 | 0. | |
| 200,000 | | .1600 | | − .30 | .05 | |
| 10,000 | | | .0080 | − .07 | 0. | |
| 220,000 | | | | − .40 | .10 | |
| 240,000 | | | | − .48 | .15 | |
| 240,000 | | | | − .50 | .15 | Sustained load 5 minutes. |
| 260,000 | | | | − .60 | .15 | |
| 270,000 | | | | − .65 | .15 | |
| 280,000 | | | | − .72 | .20 | |
| 290,000 | | | | − .80 | .20 | |
| 300,000 | | | | − .90 | .20 | |
| 305,000 | | | | −1.05 | .20 | |
| 305,000 | | | | −1.25 | .25 | Sustained load 5 minutes. |
| 310,000 | 2,900 | | | | | Ultimate strength. |

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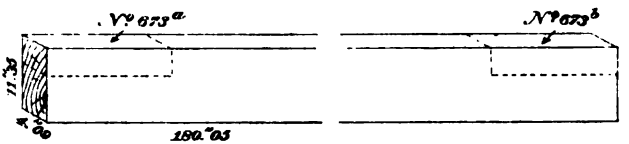
Sustained maximum load about five minutes, yielding laterally in the mean time, following the direction of the initial bend; convex on heart-side of post.

Time of test three-quarters of an hour.

## COMPRESSION TESTS OF YELLOW PINE—(Continued).

### SINGLE STICKS AND BUILT POSTS.

### No. 673.




Sectional area, 46.4 square inches.
Gauged length, 150″.
Weight, 260 pounds.
Average rate of growth, 11 rings per inch.

| Loads applied. | Pounds per square inch. | Compression. | Compression set. | Deflections. Horizontal. | Deflections. Vertical, W. | Deflections. Vertical. E. | Remarks. |
|---|---|---|---|---|---|---|---|
| *Pounds.* | | *Inch.* | *Inch.* | *Inch.* | *Inch.* | *Inch.* | |
| 0 | 0 | 0. | 0. | 0. | 0. | 0. | North end of stick very resinous. |
| 23,200 | 500 | .0370 | ..... | +—.01 | 0. | ..... | |
| 0 | 0 | ..... | .0028 | ..... | ..... | ..... | |
| 30,000 | ..... | ..... | ..... | —.01 | 0. | ..... | |
| 40,000 | ..... | ..... | ..... | —.01 | .01 | ..... | |
| 50,000 | ..... | ..... | ..... | —.01 | .02 | —.04 | |
| 60,000 | ..... | ..... | ..... | —.01 | .03 | ..... | |
| 70,000 | ..... | ..... | ..... | —.01 | .06 | ..... | |
| 80,000 | ..... | ..... | ..... | —.01 | .07 | ..... | |
| 90,000 | ..... | ..... | ..... | —.03 | .09 | ..... | |
| 100,000 | ..... | ..... | ..... | —.05 | .10 | —.08 | |
| 110,000 | ..... | ..... | ..... | —.09 | .11 | ..... | |
| 120,000 | ..... | ..... | ..... | —.13 | .12 | ..... | |
| 130,000 | ..... | ..... | ..... | —.22 | .13 | ..... | |
| 140,000 | ..... | ..... | ..... | —.50 | .13 | ..... | |
| 142,200 | 3,065 | ..... | ..... | —.95 | ..... | ..... | Ultimate strength. |
| Failed by horizontal deflection, minus direction. | | | | | | | |
| 120,000 | 2,586 | ..... | ..... | —2.50 | ..... | ..... | Sudden deflection increasing —5″. |

Specimen No. 673*a*, 20″ long, cut from north end of stick.
Specimen No. 673*b*, 20″ long, cut from south end of stick.

| Specimen. | Weight. | Size. | Sectional area. | Ultimate strength. Actual. | Ultimate strength. Pounds per square inch. | Remarks. |
|---|---|---|---|---|---|---|
| | *Pounds.* | *Inches.* | *Sq. inches.* | *Pounds.* | | |
| 673*a* | 13 | 4.01 × 4.01 | 16.08 | 94,000 | 5,846 | Fibers crushed. |
| 673*b* | 7¼ | 3.95 × 3.97 | 15.68 | 99,600 | 6,352 | Fibers crushed; small rent in specimen at corner not affecting over 5 per cent. of sectional area of stick. |

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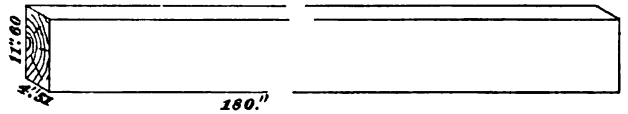
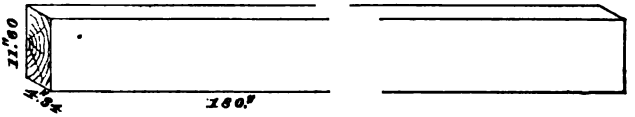
## No. 674.




Sectional area, 52.3 square inches.
Gauged length, 150″.
Weight, 233 pounds.
Average rate of growth, 17 rings per inch.

| Loads applied. | Pounds per square inch. | Compression. | Compression set. | Deflections. | | | Remarks. |
|---|---|---|---|---|---|---|---|
| | | | | Horizontal. | Vertical, W. | Vertical, E. | |
| *Pounds.* | | *Inch.* | *Inch.* | *Inch.* | *Inch.* | *Inch.* | |
| 0 | 0 | 0. | 0. | 0. | 0. | 0. | |
| 26,150 | 500 | .0492 | ..... | — .07 | — .03 | — .04 | |
| ..... | 0 | ..... | .0003 | ..... | ..... | ..... | |
| 30,000 | ..... | ..... | ..... | — .09 | — .03 | ..... | |
| 40,000 | ..... | ..... | ..... | — .10 | — .03 | ..... | |
| 50,000 | ..... | ..... | ..... | — .11 | — .03 | ..... | |
| 60,000 | ..... | ..... | ..... | — .14 | — .04 | ..... | |
| 70,000 | ..... | ..... | ..... | — .17 | — .05 | ..... | |
| 80,000 | ..... | ..... | ..... | — .20 | — .06 | ..... | |
| 90,000 | ..... | ..... | ..... | — .25 | — .07 | ..... | |
| 100,000 | ..... | ..... | ..... | — .32 | — .08 | — .06 | |
| 110,000 | ..... | ..... | ..... | — .41 | — .09 | ..... | |
| 120,000 | ..... | ..... | ..... | — .58 | — .09 | ..... | |
| 130,000 | ..... | ..... | ..... | —1.00 | — .10 | ..... | |
| 131,500 | 2,515 | ..... | ..... | —1.30 | — .12 | ..... | Ultimate strength. |
| Failed by horizontal deflection, minus direction. | | | | | | | |
| 110,000 | ..... | ..... | ..... | —3.30 | ..... | ..... | Sudden spring, increasing horizontal deflection to — 5″. |

## No. 675.




Sectional area, 50.3 square inches.
Gauged length, 150″.
Weight, 194 pounds.
Average rate of growth, 22 rings per inch.



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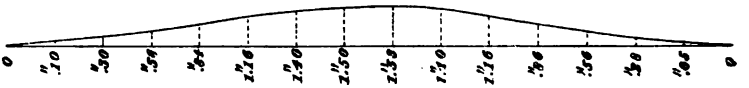
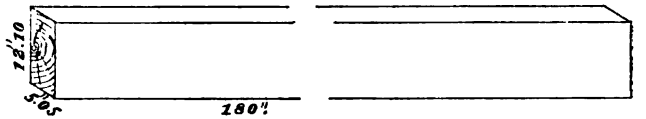
| Loads applied. | Pounds per square inch. | Compression. | Compression set. | Deflections. Horizontal. | Deflections. Vertical, W. | Deflections. Vertical, E. | Remarks. |
|---|---|---|---|---|---|---|---|
| *Pounds.* | | *Inch.* | *Inch.* | *Inch.* | *Inch.* | *Inch.* | |
| 0 | 0 | 0. | | 0. | 0. | 0. | |
| 25,150 | 500 | .0490 | | .01 | 0. | | |
| | 0 | | .0006 | | | | |
| 30,000 | | | | .02 | 0, | | |
| 40,000 | | | | .02 | 0. | | |
| 50,000 | | | | .03 | 0. | .01 | |
| 60,000 | | | | .04 | — .01 | | |
| 70,000 | | | | .05 | — .02 | | |
| 80,000 | | | | .07 | — .02 | | |
| 90,000 | | | | .10 | — .03 | | |
| 100,000 | | | | .15 | — .03 | .05 | |
| 110,000 | | | | .24 | — .04 | | |
| 120,000 | | | | .65 | — .05 | | |
| 121,200 | 2,410 | | | .90 | — .05 | | Ultimate strength. |

Failed by horizontal deflection, minus direction.

*Sketch showing of flexure, ordinates measured every 12″.*




No. 490.




Sectional area, 61.1 square inches.
Weight, 269 pounds.
Gauged length, 160″.
Post free from knots.

| Loads applied. | Pounds per square inch. | Compression. | Compression set. | Deflections. Horizontal. | Deflections. Vertical, W. | Remarks. |
|---|---|---|---|---|---|---|
| *Pounds.* | | *Inch.* | *Inch.* | *Inch.* | *Inch.* | |
| 10,000 | | 0. | 0. | 0. | 0. | |
| 20,000 | | .0140 | | 0. | 0. | |
| 40,000 | | .0416 | | — .01 | 0. | |
| 50,000 | | .0570 | | — .02 | 0. | |
| 10,000 | | | .0010 | 0. | 0. | |
| 60,000 | | .0708 | | — .02 | 0. | |
| 80,000 | | .0995 | | — .02 | 0. | |
| 100,000 | | .1318 | | — .03 | 0. | |
| 10,000 | | | .0035 | 0. | 0. | |
| 120,000 | | .1615 | | — .04 | 0. | |
| 140,000 | | .1900 | | — .04 | 0. | Snapping sound heard; sliver starting off at edge. |
| 150,000 | | .2070 | | — .05 | 0. | |
| 10,000 | | | .0060 | | | |
| 10,000 | | | .0050 | | | Rested 2 minutes. |
| 10,000 | | | .0040 | | | Rested 5 minutes. |
| 160,000 | | .2220 | | — .05 | 0. | |
| 180,000 | | .2524 | | — .05 | 0. | |
| 200,000 | | .2873 | | — .05 | 0. | |
| 10,000 | | | .0098 | 0. | 0. | |
| 230,000 | 3,764 | | | + .01 | 0. | Ultimate strength. |
| 230,000 | | | | +1.30 | 0. | After sustaining load 4 minutes. |
| 230,000 | | | | +1.80 | 0. | Maximum deflection. |
| 10,000 | | | | + .40 | 0. | |

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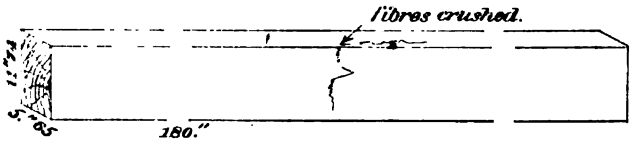
Time of test, one hour.
Failed by horizontal deflection.
Deflections changed in direction horizontally when the maximum load was reached.
Failing finally by bending concave on the heart-side of the post.

No. 670.

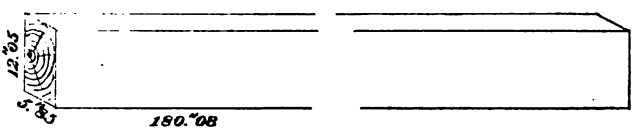



Sectional area, 66.3 square inches.
Gauged length, 150".
Weight, 309 pounds.
Average rate of growth, 12 rings per inch.

| Loads applied. | Pounds per square inch. | Compression. | Compression set. | Deflections. Horizontal. | Deflections. Vertical, W. | Deflections. Vertical, E. | Remarks. |
|---|---|---|---|---|---|---|---|
| *Pounds.* | | *Inch.* | *Inch.* | *Inch.* | *Inch.* | *Inch.* | |
| 0 | 0 | 0. | ..... | 0. | 0. | 0. | |
| 33,150 | 500 | .0455 | ..... | 0. | — .04 | ..... | |
| 0 | 0 | ..... | .0005 | ..... | ..... | ..... | |
| 50,000 | ..... | ..... | ..... | — .01 | — .06 | ..... | |
| 70,000 | ..... | ..... | ..... | — .02 | — .09 | ..... | |
| 90,000 | ..... | ..... | ..... | — .02 | — .11 | ..... | |
| 100,000 | ..... | ..... | ..... | — .02 | — .11 | .10 | |
| 120,000 | ..... | ..... | ..... | 0. | — .15 | ..... | |
| 140,000 | ..... | ..... | ..... | .02 | — .18 | ..... | |
| 150,000 | ..... | ..... | ..... | .04 | — .20 | .15 | |
| 160,000 | ..... | ..... | ..... | .07 | — .20 | ..... | |
| 170,000 | ..... | ..... | ..... | .10 | — .21 | ..... | |
| 180,000 | ..... | ..... | ..... | .13 | — .23 | ..... | |
| 190,000 | ..... | ..... | ..... | .18 | — .25 | ..... | |
| 200,000 | ..... | ..... | ..... | .31 | — .28 | .23 | |
| 206,900 | 3,106 | ..... | ..... | .70 | — .29 | ..... | Ultimate strength. |

Failed by horizontal deflection, plus direction.
Fibers crushed near middle of stick, line of failure taking an oblique course.

No. 489.




Sectional area, 70.5 square inches.
Weight, 287 pounds.
Gauged length, 160".
Post free from knots.

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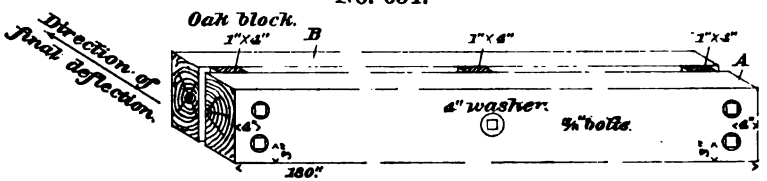
| Loads applied. | Pounds square per inch. | Compression. | Compression set. | Deflections. Horizontal. | Deflections. Vertical, W. | Remarks. |
|---|---|---|---|---|---|---|
| *Pounds.* | | *Inch.* | *Inch.* | *Inch.* | *Inch.* | |
| 10,000 | ..... | 0. | 0. | 0. | 0. | |
| 20,000 | ..... | .0114 | ..... | 0. | 0. | |
| 40,000 | ..... | .0368 | ..... | —.01 | 0. | |
| 50,000 | ..... | .0405 | ..... | —.02 | 0. | |
| 10,000 | ..... | ..... | 0. | 0. | 0. | |
| 60,000 | ..... | .0630 | ..... | —.02 | 0. | |
| 80,000 | ..... | .0895 | ..... | —.04 | 0. | |
| 100,000 | ..... | .1162 | ..... | —.04 | 0. | |
| 10,000 | ..... | ..... | .0004 | 0. | 0. | |
| 120,000 | ..... | .1435 | ..... | —.08 | 0. | |
| 140,000 | ..... | .1710 | ..... | —.10 | 0. | |
| 150,000 | ..... | .1850 | ..... | —.10 | 0. | |
| 10,000 | ..... | ..... | .0025 | 0. | 0. | |
| 160,000 | ..... | .1980 | ..... | —.12 | 0. | [minutes. |
| 160,000 | ..... | .2008 | ..... | —.12 | 0. | Sustained load 5 |
| 160,000 | ..... | .2020 | ..... | —.12 | 0. | Sustained load 10 |
| 170,000 | ..... | .2160 | ..... | —.15 | 0. | minutes. |
| 180,000 | ..... | .2295 | ..... | —.18 | 0. | |
| 180,000 | ..... | .2310 | ..... | —.20 | 0. | |
| 190,000 | ..... | .2450 | ..... | —.20 | 0. | |
| 200,000 | ..... | .2585 | ..... | —.21 | 0. | |
| 10,000 | ..... | ..... | .0082 | —.01 | 0. | |
| 10,000 | ..... | ..... | .0060 | —.01 | 0. | After 5 minutes |
| 210,000 | ..... | ..... | ..... | —.27 | 0. | rest. |
| 220,000 | ..... | ..... | ..... | —.31 | 0. | |
| 230,000 | ..... | ..... | ..... | —.38 | 0. | |
| 240,000 | ..... | ..... | ..... | —.50 | 0. | |
| 250,000 | 3,546 | ..... | ..... | —.73 | 0. | Ultimate strength. |
| 250,000 | ..... | ..... | ..... | —1.26 | ..... | Sustained load 5 minutes. |

Failed by horizontal deflection; convex on heart-side of post. After sustaining load five minutes, horizontal deflection increased rapidly, opening longitudinal cracks along middle of post near the heart of the wood.

Time of test one and a half hours.

No. 654.




*Preliminary test of the single sticks.*

| Stick. | Weight. | Rings per inch. | Total length. | Width. | Depth. | Sectional area. | Gauged length. |
|---|---|---|---|---|---|---|---|
| | *Pounds.* | | *Inches.* | *Inches.* | *Inches.* | *Sq. inches.* | *Inches.* |
| A | 326 | 11 | 180 | 5.63 | 11.71 | 65.9 | 150 |
| B | 290 | 6 | 180 | 5.62 | 11.71 | 65.9 | 150 |
| | 616 | ..... | ..... | ..... | ..... | 131.8 | ..... |

| Stick. | Loads applied. Actual. | Loads applied. Pounds per sq. inch. | Compression. | Compression set. | Horizontal deflection. | Permanent horizontal deflection. |
|---|---|---|---|---|---|---|
| | *Pounds* | | *Inch.* | *Inch.* | *Inch.* | *Inch.* |
| A | 32,950 | 500 | .0418 | .0002 | .03 | 0. |
| B | 32,950 | 500 | .0540 | 0. | 0. | 0. |

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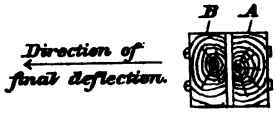
*Test of the built post.*

| Loads applied. | Deflections. Horizontal. | Vertical, W. | Vertical, E. | Remarks. |
|---|---|---|---|---|
| *Pounds.* | *Inch.* | *Inch.* | *Inch.* | |
| 10,000 | 0. | 0. | 0. | |
| 20,000 | 0. | 0. | 0. | |
| 40,000 | 0. | 0. | 0. | |
| 80,000 | 0. | 0. | 0. | |
| 100,000 | 0. | 0. | 0. | |
| 140,000 | 0. | .01 | — .01 | |
| 180,000 | 0. | .02 | — .02 | |
| 200,000 | 0. | .02 | — .02 | |
| 220,000 | 0. | .03 | — .03 | |
| 240,000 | 0. | .04 | — .03 | |
| 260,000 | 0. | .05 | — .03 | |
| 280,000 | .01 | .07 | — .04 | |
| 300,000 | .01 | .08 | — .04 | |
| 320,000 | .03 | .09 | — .04 | |
| 340,000 | .04 | .10 | — .04 | |
| 360,000 | .05 | .11 | — .04 | |
| 380,000 | .07 | .12 | — .04 | |
| 400,000 | .10 | .14 | — .04 | |
| 410,000 | .11 | .15 | — .04 | |
| 420,000 | .12 | .16 | — .04 | |
| 430,000 | .14 | .16 | — .04 | |
| 440,000 | .20 | .18 | — .04 | |
| 450,000 | .23 | .20 | — .04 | |
| 460,000 | .29 | .22 | — .04 | |
| 470,000 | .39 | .22 | — .04 | Ultimate strength = 3,566 pounds per square inch. |

**Failed by horizontal deflection, plus direction.**

## No. 655.

**Same style of post as No. 654.**




*Preliminary test of the single sticks.*

| Stick. | Weight. | Rings per inch. | Total length. | Width. | Depth. | Sectional area. | Gauged length. |
|---|---|---|---|---|---|---|---|
| | *Pounds.* | | *Inches.* | *Inches.* | *Inches.* | *Sq. inches.* | *Inches.* |
| A | 292 | 34 | 179.93 | 5.64 | 11.72 | 66.1 | 150 |
| B | 329 | 24 | 179.93 | 5.63 | 11.72 | 66.1 | 150 |
| | 621 | | | | | 132.2 | |

| Stick. | Loads applied. Actual. | Pounds per sq. inch. | Compression. | Compression set. | Horizontal deflection. | Permanent horizontal deflection. |
|---|---|---|---|---|---|---|
| | *Pounds.* | | *Inch.* | *Inch.* | *Inch.* | *Inch.* |
| A | 33,050 | 500 | .0292 | 0. | .03 | 0. |
| B | 33,050 | 500 | .0315 | .0007 | 0. | 0. |

Digitized by Google

*Test of the built post.*

| Loads applied. | Deflections. | | | Remarks. |
|---|---|---|---|---|
| | Horizontal. | Vertical, W. | Vertical, E. | |
| *Pounds.* | *Inch.* | *Inch.* | *Inch.* | |
| 10,000 | 0. | 0. | 0. | |
| 20,000 | 0. | 0. | 0. | Sticks straight-grained, free from knots. |
| 40,000 | 0. | 0. | 0. | |
| 80,000 | 0. | .01 | — .01 | |
| 100,000 | 0. | .02 | — .01 | |
| 140,000 | 0. | .02 | — .01 | |
| 180,000 | 0. | .01 | — .01 | |
| 200,000 | 0. | .01 | — .01 | |
| 240,000 | 0. | .01 | — .01 | |
| 280,000 | 0. | .01 | — .01 | |
| 300,000 | 0. | .01 | — .01 | |
| 320,000 | 0. | .01 | — .01 | |
| 340,000 | 0. | 0. | 0. | |
| 350,000 | 0. | 0. | 0. | |
| 360,000 | 0. | 0. | 0. | |
| 370,000 | 0. | 0. | 0. | |
| 380,000 | 0. | 0. | 0. | |
| 390,000 | 0. | 0. | 0. | |
| 400,000 | 0. | 0. | 0. | |
| 410,000 | 0. | 0. | 0. | |
| 420,000 | 0. | — .01 | .01 | |
| 430,000 | — .01 | — .01 | .01 | |
| 440,000 | — .01 | — .01 | .01 | |
| 450,000 | — .01 | — .01 | .01 | |
| 460,000 | — .01 | — .01 | .01 | |
| 470,000 | — .01 | — .01 | .01 | |
| 480,000 | — .01 | — .01 | .01 | |
| 490,000 | — .01 | — .01 | .01 | |
| 500,000 | — .01 | — .01 | .01 | |
| 510,000 | 0. | — .02 | .02 | |
| 520,000 | 0. | — .03 | .03 | |
| 530,000 | .01 | — .04 | .04 | |
| 540,000 | .02 | — .05 | .05 | |
| 550,000 | .05 | — .06 | ..... | |
| 560,000 | .10 | — .08 | ..... | |
| 570,000 | .17 | — .09 | ..... | |
| 580,000 | ..... | ..... | ..... | Ultimate strength = 4,387 pounds per square inch. |
| Failed by horizontal deflection in plus direction. Loads continued after passing the ultimate strength, increasing the horizontal deflection. | | | | |
| 527,000 | 1.30 | Maximum load now sustained. | | |
| 10,000 | ..... | Rested 36 hours. | | |
| 7,500 | ..... | Load on post at end of 36 hours. | | |
| 509,000 | 1.40 | Maximum load sustained after 36 hours' rest. | | |

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## No. 656.

Same style of post as No. 654.

*Preliminary test of the single sticks.*

| Stick. | Weight. | Rings per inch. | Total length. | Width. | Depth. | Sectional area. | Gauged length. |
|---|---|---|---|---|---|---|---|
| | *Pounds.* | | *Inches.* | *Inches.* | *Inches.* | *Sq. inches.* | *Inches.* |
| A | 282 | 13 | 180 | 5.61 | 11.71 | 65.7 | 150 |
| B | 287 | 11 | 180 | 5.61 | 11.71 | 65.7 | 150 |
| | 569 | ..... | ..... | ..... | ..... | 131.4 | ..... |

| Stick. | Loads applied. | | Compression. | Compression set. | Horizontal deflection. | Permanent horizontal deflection. |
|---|---|---|---|---|---|---|
| | Actual. | Pounds per square inch. | | | | |
| | *Pounds.* | | *Inch.* | *Inch.* | *Inch.* | *Inch.* |
| A | 32,850 | 500 | .0368 | .0002 | −.02 | 0. |
| B | 32,850 | 500 | .0466 | .0008 | −.06 | 0. |

*Test of the built post.*

| Loads applied. | Deflections. | | | Remarks. |
|---|---|---|---|---|
| | Horizontal. | Vertical, W. | Vertical, E. | |
| *Pounds.* | *Inch.* | *Inch.* | *Inch.* | |
| 10,000 | 0. | 0. | 0. | |
| 20,000 | 0. | 0. | 0. | |
| 40,000 | 0. | +.01 | −.01 | |
| 80,000 | 0. | +.01 | −.01 | |
| 100,000 | 0. | .02 | 0. | |
| 140,000 | −.01 | .02 | 0. | |
| 180,000 | −.04 | .01 | 0. | |
| 200,000 | −.04 | .01 | 0. | |
| 220,000 | −.05 | .01 | 0. | |
| 240,000 | −.06 | 0. | .01 | |
| 260,000 | −.06 | 0. | .01 | |
| 280,000 | −.07 | 0. | .01 | |
| 300,000 | −.07 | −.01 | .02 | |
| 320,000 | −.08 | −.01 | .02 | |
| 340,000 | −.09 | −.01 | .02 | |
| 360,000 | −.10 | −.01 | .02 | |
| 380,000 | −.11 | −.01 | .02 | |
| 400,000 | −.12 | −.02 | ..... | |
| 420,000 | −.16 | −.02 | ..... | |
| 440,000 | −.21 | −.04 | +.04 | |
| 450,000 | −.27 | −.04 | +.04 | |
| 460,000 | −.33 | −.04 | +.04 | |
| 470,000 | −.52 | −.04 | +.04 | |
| 480,000 | −.65 | −.04 | +.04 | Ultimate strength = 3,653 pounds per square inch. |

**Failed by horizontal deflection, minus direction.**

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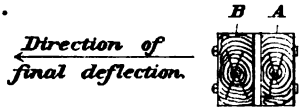
## No. 651.

## YELLOW PINE, SWELLED POSTS.




*Preliminary test of the single sticks.*

| Stick. | Weight. | Rings per inch. | Total length. | Width. | Depth. | Sectional area. | Gauged length. |
|---|---|---|---|---|---|---|---|
| | *Pounds.* | | *Inches.* | *Inches.* | *Inches.* | *Sq. inches.* | *Inches.* |
| A | 262 | 11 | 180 | 5.58 | 11.71 | 65.3 | 150 |
| B | 275 | 7 | 180 | 5.58 | 11.71 | 65.3 | 150 |
| | 537 | ..... | ..... | ..... | ..... | 130.6 | ..... |

| Stick. | Loads applied. | | Compression. | Compression set. | Horizontal deflection. | Permanent horizontal deflection. |
|---|---|---|---|---|---|---|
| | Actual. | Pounds per square inch. | | | | |
| | *Pounds.* | | *Inch.* | *Inch.* | *Inch.* | *Inch.* |
| A | 32,650 | 500 | .0620 | .0014 | − .19 | − .02 |
| B | 32,650 | 500 | .0514 | .0008 | .13 | 0. |

*Test of the built post.*

| Loads applied. | Deflections. | | | Remarks. |
|---|---|---|---|---|
| | Horizontal. | Vertical, W. | Vertical, E. | |
| *Pounds.* | *Inch.* | *Inch.* | *Inch.* | |
| 10,000 | 0. | 0. | ..... | |
| 20,000 | 0. | 0. | ..... | |
| 40,000 | 0. | 0. | ..... | |
| 60,000 | 0. | 0. | ..... | |
| 80,000 | 0. | 0. | ..... | |
| 100,000 | 0. | 0. | ..... | |
| 120,000 | 0. | 0. | ..... | |
| 140,000 | 0. | 0. | ..... | |
| 160,000 | 0. | 0. | ..... | |
| 180,000 | 0. | 0. | ..... | |
| 200,000 | 0. | 0. | ..... | |
| 220,000 | 0. | − .01 | + .02 | |
| 240,000 | 0. | − .02 | + .04 | |
| 260,000 | 0. | − .03 | .05 | |
| 280,000 | 0. | − .04 | .05 | |
| 300,000 | 0. | − .05 | .06 | |
| 320,000 | 0. | − .07 | .07 | |
| 340,000 | 0. | − .09 | .09 | |
| 360,000 | .07 | − .11 | .11 | Ultimate strength = 2,756 pounds per square inch. |
| 360,000 | .47 | − .17 | ..... | After sustaining load 5 minutes. |

**Post failed by horizontal deflection in plus direction.**

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## No. 652.

Same style of post as No. 651.

*Preliminary test of the single sticks.*

| Stick. | Weight. | Rings per inch. | Total length. | Width. | Depth. | Sectional area. | Gauged length. |
|---|---|---|---|---|---|---|---|
| | *Pounds.* | | *Inches.* | *Inches.* | *Inches.* | *Sq. inches.* | *Inches.* |
| A | 310 | 16 | 180 | 5.58 | 11.70 | 65.3 | 150 |
| B | 370 | 16 | 180 | 5.58 | 11.71 | 65.3 | 150 |
| | 680 | ..... | ..... | ..... | ..... | 130.6 | ..... |

| Stick. | Loads applied. | | Compression. | Compression set. | Horizontal deflection. | Permanent horizontal deflection. |
|---|---|---|---|---|---|---|
| | Actual. | Pounds per square inch. | | | | |
| | *Pounds.* | | *Inch.* | *Inch.* | *Inch.* | *Inch.* |
| A | 32,650 | 500 | .0395 | .0008 | — .20 | 0. |
| B | 32,650 | 500 | .0360 | .0002 | .18 | .03 |

Transversely the sticks bend an equal amount when bolted together.

*Test of the built post.*

| Loads applied. | Deflections. | | | Remarks. |
|---|---|---|---|---|
| | Horizontal. | Vertical, W. | Vertical, E. | |
| *Pounds.* | *Inch.* | *Inch.* | *Inch.* | |
| 10,000 | 0. | 0. | 0. | Sticks A and B straight grained and free from knots. |
| 20,000 | 0. | 0. | 0. | |
| 40,000 | 0. | — .01 | — .01 | |
| 60,000 | 0. | — .01 | — .01 | |
| 80,000 | 0. | — .01 | — .01 | |
| 100,000 | 0. | — .01 | — .01 | |
| 140,000 | 0. | 0. | 0. | |
| 180,000 | 0. | 0. | 0. | |
| 200,000 | 0. | 0. | 0. | |
| 220,000 | 0. | 0. | 0. | |
| 240,000 | 0. | 0. | 0. | |
| 260,000 | 0. | — .01 | + .01 | |
| 280,000 | 0. | — .01 | .01 | |
| 300,000 | 0. | — .01 | .01 | |
| 320,000 | 0. | — .01 | .01 | |
| 340,000 | 0. | — .01 | .01 | |
| 360,000 | 0. | — .02 | .02 | |
| 380,000 | 0. | — .02 | .02 | |
| 400,000 | 0. | — .02 | .02 | |
| 410,000 | 0. | — .03 | .03 | |
| 420,000 | 0. | — .04 | .04 | |
| 430,000 | 0. | — .04 | .04 | |
| 440,000 | 0. | — .04 | .04 | |

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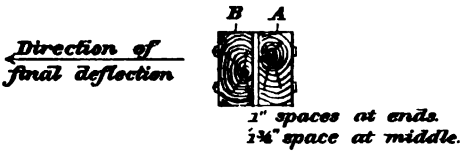
| Loads applied. | Deflections. | | | Remarks. |
|---|---|---|---|---|
| | Horizontal. | Vertical, W. | Vertical, E. | |
| *Pounds.* | *Inch.* | *Inch.* | *Inch.* | |
| 450,000 | 0. | — .05 | .05 | |
| 460,000 | 0. | — .05 | .05 | |
| 470,000 | 0. | — .05 | .05 | |
| 480,000 | 0. | — .05 | .05 | |
| 490,000 | 0. | — .05 | .05 | |
| 500,000 | 0. | — .05 | .05 | |
| 510,000 | 0. | — .05 | .05 | |
| 520,000 | 0. | — .05 | .05 | |
| 530,000 | 0. | — .05 | .05 | |
| 540,000 | 0. | — .05 | .05 | |
| 550,000 | 0. | — .06 | .05 | |
| 560,000 | — .01 | — .06 | .05 | |
| 570,000 | — .02 | — .06 | .05 | |
| 580,000 | — .09 | — .06 | .05 | |
| 585,000 | — .17 | — .06 | .05 | |
| 588,500 | — .36 | — .06 | .05 | Ultimate strength = 4,506 pounds per square inch. |

**Failed by horizontal deflection in minus direction.**

## No. 653.

**Same style of post as No. 651.**




***Preliminary test of the single sticks.***

| Stick. | Weight. | Rings per inch. | Total length. | Width. | Depth. | Sectional area. | Gauged length. |
|---|---|---|---|---|---|---|---|
| | *Pounds.* | | *Inches.* | *Inches.* | *Inches.* | *Sq. inches.* | *Inches.* |
| A | 310 | 16 | 180 | 5.63 | 11.71 | 65.9 | 150 |
| B | 311 | 12 | 180 | 5.59 | 11.68 | 65.3 | 150 |
| | 621 | ..... | ..... | ..... | ..... | 131.2 | ..... |

| Stick. | Loads applied. | | Compression. | Compression set. | Horizontal deflection. | Permanent horizontal deflection. |
|---|---|---|---|---|---|---|
| | Actual. | Pounds per square inch. | | | | |
| | *Pounds.* | | *Inch.* | *Inch.* | *Inch.* | *Inch.* |
| A | 32,950 | 500 | .0550 | .0008 | — .26 | — .01 |
| B | 32,650 | 500 | .0550 | 0. | — .12 | .02 |

**Transversely the sticks bend an equal amount when bolted together.**

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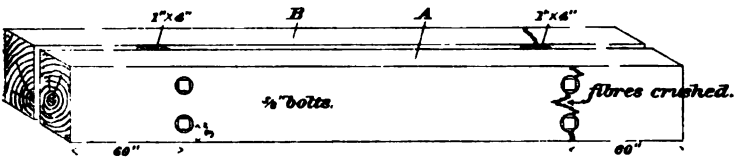
*Test of the built post.*

| Loads applied. | Deflections. | | | Remarks. |
|---|---|---|---|---|
| | Horizontal. | Vertical, W. | Vertical, E. | |
| *Pounds.* | *Inch.* | *Inch.* | *Inch.* | |
| 10,000 | 0. | 0. | 0. | |
| 20,000 | 0. | .01 | 0. | |
| 40,000 | 0. | .01 | 0. | |
| 80,000 | 0. | .02 | 0. | |
| 100,000 | .01 | .02 | 0, | |
| 140,000 | .01 | .02 | 0. | |
| 160,000 | .01 | .02 | 0. | |
| 180,000 | .01 | .02 | 0. | |
| 200,000 | .02 | .02 | 0. | |
| 220,000 | .02 | .02 | 0. | |
| 240,000 | .02 | .02 | 0. | |
| 260,000 | .03 | .01 | 0. | |
| 280,000 | .05 | .01 | 0. | |
| 300,000 | .05 | .01 | 0. | |
| 320,000 | .06 | .01 | 0. | |
| 340,000 | .09 | .01 | 0. | |
| 360,000 | .10 | .01 | 0. | |
| 370,000 | .11 | .01 | 0. | |
| 390,000 | .14 | .01 | 0. | |
| 400,000 | .16 | .01 | 0. | |
| 410,000 | .20 | .01 | 0. | |
| 420,000 | .28 | .01 | 0. | |
| 430,000 | .40 | .01 | 0. | |
| 436,600 | .60 | .01 | 0. | Ultmate strength = 3,328 pounds per square inch. |

Stick B failed 32″ from middle, fibers crushing at a group of knots. Post took horizontal deflection in plus direction.

## No. 657.




*Preliminary test of the single sticks.*

| Stick. | Weight. | Rings per inch. | Total length. | Width. | Depth. | Sectional area. | Gauged length. |
|---|---|---|---|---|---|---|---|
| | *Pounds.* | | *Inches.* | *Inches.* | *Inches.* | *Sq. inches.* | *Inches.* |
| A | 340 | 9 | 179.96 | 5.63 | 11.72 | 66.0 | 150 |
| B | 319 | 13 | 179.96 | 5.64 | 11.71 | 66.0 | 150 |
| | 659 | ..... | ..... | ..... | ..... | 132.0 | ..... |

| Stick. | Loads applied. | | Compression. | Compression set. | Horizontal deflection. | Permanent horizontal deflection. |
|---|---|---|---|---|---|---|
| | Actual. | Pounds per square inch. | | | | |
| | *Pounds.* | | *Inch.* | *Inch.* | *Inch.* | *Inch.* |
| A | 33,000 | 500 | .0375 | 0. | — .05 | — .01 |
| B | 33,000 | 500 | .0305 | 0. | — .02 | 0. |

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*Test of the built post.*

| Loads applied. | Deflections. | | | Remarks. |
|---|---|---|---|---|
| | Horizontal. | Vertical, W. | Vertical, E. | |
| *Pounds.* | *Inch.* | *Inch.* | *Inch.* | |
| 10,000 | 0. | 0. | 0. | |
| 20,000 | 0. | .01 | 0. | |
| 40,000 | 0. | .02 | ..... | |
| 80,000 | 0. | .04 | .04 | |
| 100,000 | 0. | .06 | ..... | |
| 140,000 | 0. | .10 | ..... | |
| 180,000 | 0. | .12 | ..... | |
| 200,000 | 0. | .14 | .10 | |
| 220,000 | 0. | .15 | ..... | |
| 240,000 | 0. | .16 | ..... | |
| 260,000 | 0. | .18 | ..... | |
| 280,000 | 0. | .20 | ..... | |
| 300,000 | 0. | .21 | .12 | |
| 320,000 | 0. | .23 | ..... | |
| 340,000 | 0. | .25 | ..... | |
| 360,000 | 0. | .27 | ..... | |
| 380,000 | 0. | .29 | ..... | |
| 400,000 | 0. | .31 | ..... | |
| 420,000 | 0. | .32 | .15 | |
| 440,000 | 0. | .35 | ..... | |
| 460,000 | 0. | .37 | ..... | |
| 480,000 | 0. | .40 | ..... | |
| 500,000 | 0. | .42 | ..... | |
| 520,000 | 0. | .47 | ..... | |
| 540,000 | 0. | .50 | ..... | |
| 560,000 | — .02 | .57 | ..... | |
| 580,000 | — .09 | .65 | ..... | Ultimate strength = 4,394 pounds per square inch. |

Failed by crushing fibers at bolt-holes.

## No. 658.

## Same style of post as No. 657.

*Preliminary test of the single sticks.*

| Stick. | Weight. | Rings per inch. | Total length. | Width. | Depth. | Sectional area. | Gauged length. |
|---|---|---|---|---|---|---|---|
| | *Pounds.* | | *Inches.* | *Inches.* | *Inches.* | *Sq. inches.* | *Inches.* |
| A | 319 | 12 | 179.98 | 5.59 | 11.71 | 65.5 | 150 |
| B | 332 | 9 | 179.98 | 5.59 | 11.72 | 65.5 | 150 |
| | 651 | ..... | ..... | ..... | ..... | 131.0 | ..... |

| Stick. | Loads applied. | | Compression. | Compression set. | Horizontal deflection. | Permanent horizontal deflection. |
|---|---|---|---|---|---|---|
| | Actual. | Pounds per square inch. | | | | |
| | *Pounds.* | | *Inch.* | *Inch.* | *Inch.* | *Inch.* |
| A | 32,750 | 500 | .0320 | .0065 | .08 | 0. |
| B | 32,750 | 500 | .0436 | .0008 | — .04 | 0. |

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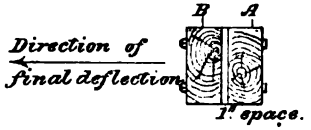
*Test of the built post.*

| Loads applied. | Deflections. Horizontal. | Vertical, W. | Vertical, E. | Remarks. |
|---|---|---|---|---|
| *Pounds.* | *Inch.* | *Inch.* | *Inch.* | |
| 10,000 | 0. | 0. | 0. | Sticks in poor condition; contain bad shakes and season-cracks. Oblique to axis of sticks. |
| 20,000 | 0. | 0. | ..... | |
| 40,000 | .02 | .07 | — .07 | |
| 80,000 | .02 | .12 | ..... | |
| 100,000 | 0. | .15 | ..... | |
| 140,000 | 0. | .20 | ..... | |
| 180,000 | 0. | .25 | ..... | |
| 200,000 | — .01 | .28 | — .28 | |
| 220,000 | — .02 | .30 | ..... | |
| 240,000 | — .04 | .32 | ..... | |
| 260,000 | — .05 | .33 | ..... | |
| 280,000 | — .06 | .35 | ..... | |
| 300,000 | — .08 | .35 | — .20 | |
| 320,000 | — .10 | .35 | ..... | |
| 340,000 | — .12 | .35 | ..... | |
| 360,000 | — .15 | .35 | ..... | |
| 380,000 | — .17 | .35 | ..... | |
| 400,000 | — .21 | .33 | — .07 | |
| 410,000 | — .27 | .25 | 0. | |
| 420,000 | — .30 | .15 | ..... | |
| 425,000 | — .41 | — .10 | + .55 | |
| 430,000 | — .48 | — .12 | ..... | |
| 440,000 | — .58 | — .27 | ..... | |
| 445,000 | — .75 | — .41 | ..... | |
| 448,000 | —1.00 | — .60 | ..... | Ultimate strength = 3,420 pounds per square inch. |

Stick B failed by opening oblique season-cracks, and shakes taking a minus horizontal deflection.

## No. 659.

Same style of post as No. 657.




*Preliminary test of the single sticks.*

| Stick. | Weight. | Rings per inch. | Total length. | Width. | Depth. | Sectional area. | Gauged length. |
|---|---|---|---|---|---|---|---|
| | *Pounds.* | | *Inches.* | *Inches.* | *Inches.* | *Sq. inches.* | *Inches.* |
| A | 320 | 12 | 180 | 5.61 | 11.73 | 65.8 | 150 |
| B | 293 | 8 | 180 | 5.61 | 11.73 | 65.8 | 150 |
| | 613 | ..... | ..... | ..... | ..... | 131.6 | ..... |

| Stick. | Loads applied. Actual. | Pounds per square inch. | Compression. | Compression set. | Horizontal deflection. | Permanent horizontal deflection. |
|---|---|---|---|---|---|---|
| | *Pounds.* | | *Inch.* | *Inch.* | *Inch.* | *Inch.* |
| A | 32,900 | 500 | .0312 | 0. | .04 | 0. |
| B | 32,900 | 500 | .0372 | .0002 | — .01 | 0. |

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*Test of the built post.*

| Loads applied. | Deflections. Horizontal. | Vertical, W. | Vertical, E. | Remarks. |
|---|---|---|---|---|
| *Pounds.* | *Inch.* | *Inch.* | *Inch.* | |
| 10,000 | 0. | 0. | 0. | |
| 20,000 | 0. | 0. | ..... | |
| 40,000 | 0. | 0. | ..... | |
| 80,000 | 0. | 0. | ..... | |
| 100,000 | 0. | 0. | ..... | |
| 140,000 | 0. | 0. | ..... | |
| 180,000 | 0. | 0. | ..... | |
| 200,000 | 0. | — .02 | .13 | |
| 220,000 | .01 | — .03 | ..... | |
| 240,000 | .02 | — .03 | .15 | |
| 260,000 | .03 | — .04 | ..... | |
| 280,000 | .03 | — .05 | ..... | |
| 300,000 | .04 | — .05 | .20 | |
| 320,000 | .05 | — .05 | ..... | |
| 340,000 | .06 | — .06 | ..... | |
| 360,000 | .07 | — .07 | ..... | |
| 380,000 | .08 | — .08 | ..... | |
| 400,000 | .10 | — .09 | .27 | |
| 440,000 | .12 | — .09 | ..... | |
| 480,000 | .15 | — .09 | .35 | |
| 500,000 | .17 | — .08 | ..... | |
| 520,000 | .20 | — .07 | ..... | |
| 540,000 | .24 | — .07 | ..... | |
| 560,000 | .30 | — .04 | ..... | |
| 580,000 | .45 | — .03 | ..... | |
| 600,000 | .70 | 0. | .47 | Ultimate strength = 4,559 pounds per square inch. |

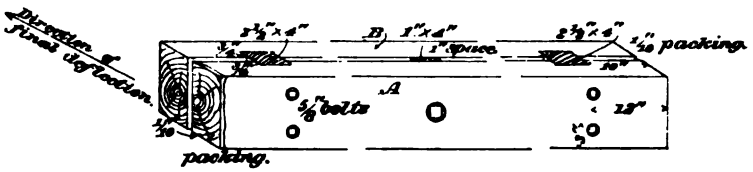
Failed by horizontal deflection, plus direction.

Deflection increased to 1″.40 horizontal without crushing fibers of either stick.

## YELLOW PINE, BUILT POSTS.

End packing blocks let into sticks.

No. 660.




*Preliminary test of the single sticks.*

| Stick. | Weight. | Rings per inch. | Total length. | Width. | Depth. | Sectional area. | Gauged length. |
|---|---|---|---|---|---|---|---|
| | *Pounds.* | | *Inches.* | *Inches.* | *Inches.* | *Sq. inches.* | *Inches.* |
| A | 283 | 25 | 180.03 | 5.61 | 11.22 | 62.9 | 150 |
| B | 294 | 18 | 180.03 | 5.63 | 11.24 | 63.3 | 150 |
| | 577 | ..... | ..... | ..... | ..... | 126.2 | ..... |

| Stick. | Loads applied. Actual. | Pounds per square inch. | Compression. | Compression set. | Horizontal deflection. | Permanent horizontal deflection. |
|---|---|---|---|---|---|---|
| | *Pounds.* | | *Inch.* | *Inch.* | *Inch.* | *Inch.* |
| A | 31,450 | 500 | .0325 | 0. | .08 | 0. |
| B | 31,650 | 500 | .0400 | 0. | 0. | 0. |

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*Test of the built post.*

Tested with uneven bearings.

Strips of yellow-pine packing $\frac{1}{10}$″ thick placed between ends of sticks and compression platform, one strip behind end of stick A, and one strip behind opposite end of stick B.

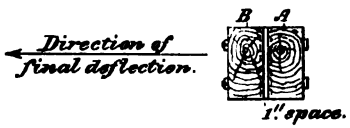
| Loads applied. | Deflections. | | | Remarks. |
|---|---|---|---|---|
| | Horizontal. | Vertical, W. | Vertical, E. | |
| *Pounds.* | | | | |
| 10,000 | 0. | 0. | 0. | |
| 20,000 | 0. | .01 | ..... | |
| 40,000 | 0. | .02 | ..... | Ends not packed came to full bearing. |
| 60,000 | 0. | .03 | ..... | |
| 80,000 | 0. | .03 | ..... | |
| 100,000 | 0. | .04 | — .02 | |
| 140,000 | 0. | .04 | ..... | |
| 180,000 | .01 | .05 | ..... | |
| 200,000 | .01 | .05 | ..... | |
| 240,000 | .02 | .05 | ..... | |
| 280,000 | .03 | .06 | ..... | |
| 300,000 | .03 | .06 | — .03 | |
| 320,000 | .03 | .06 | ..... | |
| 360,000 | .03 | .06 | ..... | |
| 400,000 | .05 | .06 | ..... | |
| 420,000 | .06 | .07 | ..... | |
| 440,000 | .09 | .07 | ..... | |
| 460,000 | .10 | .07 | ..... | |
| 480,000 | .15 | .07 | ..... | |
| 500,000 | .21 | .07 | — .05 | |
| 510,000 | .80 | 0. | ..... | Ultimate strength = 4,041 pounds per square inch. |

Failed by horizontal deflection, plus direction.

The deflection was increased to 2″.40 horizontal. At this time the fibers of the sticks had crushed at middle and where the packing pieces were notched in near the ends.

No. 661.

Same style of post as No. 660.




*Preliminary test of the single sticks.*

| Stick. | Weight. | Rings per inch. | Total length. | Width. | Depth. | Sectional area. | Gauged length. |
|---|---|---|---|---|---|---|---|
| | *Pounds.* | | *Inches.* | *Inches.* | *Inches.* | *Sq. inches.* | *Inches.* |
| A | 274 | 12 | 180 | 5.66 | 11.70 | 66.2 | 150 |
| B | 310 | 9 | 180 | 5.60 | 11.72 | 65.6 | 150 |
| | 584 | ..... | ..... | ..... | ..... | 131.8 | ..... |

| Stick. | Loads applied. | | Compression. | Compression set. | Horizontal deflection. | Permanent horizontal deflection. |
|---|---|---|---|---|---|---|
| | Actual. | Pounds per square inch. | | | | |
| | *Pounds.* | | *Inch.* | *Inch.* | *Inch.* | *Inch.* |
| A | 33,100 | 500 | .0410 | 0. | — .01 | 0. |
| B | 32,800 | 500 | .0365 | 0. | — .03 | 0. |

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*Test of the built post.*

Tested with uneven bearings.

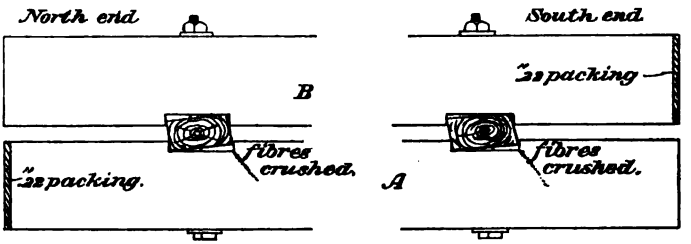
Strip of yellow pine ".22 thick placed behind north ends of stick A; same thickness of packing placed behind south end of stick B.

| Loads applied. | Deflections. | | | Remarks. |
|---|---|---|---|---|
| | Horizontal. | Vertical, W. | Vertical, E. | |
| *Pounds.* | *Inch.* | *Inch.* | *Inch.* | |
| 10,000 | 0. | 0. | 0. | |
| 20,000 | — .01 | 0. | ..... | |
| 30,000 | — .03 | .04 | ..... | Deflection rods readjusted. |
| 30,000 | 0. | 0. | 0. | |
| 40,000 | — .07 | .10 | ..... | |
| 45,000 | ..... | ..... | ..... | Ends not packed reach full bearing. |
| 50,000 | — .14 | .14 | ..... | |
| 60,000 | — .10 | .14 | — .04 | |
| 80,000 | — .10 | .14 | ..... | |
| 100,000 | — .10 | .14 | ..... | |
| 140,000 | — .04 | .15 | ..... | |
| 180,000 | — .01 | .15 | ..... | |
| 200,000 | 0. | .15 | — .05 | |
| 220,000 | 0. | .15 | ..... | |
| 240,000 | 0. | .15 | ..... | |
| 260,000 | 0. | .15 | ..... | |
| 280,000 | + .01 | .14 | ..... | |
| 300,000 | .03 | .14 | ..... | |
| 320,000 | .06 | .13 | ..... | |
| 340,000 | .09 | .13 | ..... | |
| 360,000 | .12 | .13 | ..... | |
| 380,000 | .20 | .13 | ..... | |
| 400,000 | .40 | .15 | + .07 | |
| 410,000 | .76 | .17 | ..... | Ultimate strength = 3,111 pounds per square inch. |

Failed by horizontal deflection, plus direction.

Deflections were increased after the maximum load was passed to develop lines of failure by crushing the fibers of the sticks.

Fibers of stick A crushed 15″ from middle and at notched ends, as shown by sketches below:




No. 662.

Same style of post as No. 660.

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*Preliminary test of the single sticks.*

| Stick. | Weight. | Rings per inch. | Total length. | Width. | Depth. | Sectional area. | Gauged length. |
|---|---|---|---|---|---|---|---|
| | *Pounds.* | | *Inches.* | *Inches.* | *Inches.* | *Sq. inches.* | *Inches.* |
| A | 292 | 14 | 180 | 5.61 | 11.75 | 65.9 | 150 |
| B | 280 | 8 | 180 | 5.61 | 11.75 | 65.9 | 150 |
| | 572 | ..... | ..... | ..... | ..... | 131.8 | ..... |

| Stick. | Loads applied. | | Compression. | Compression set. | Horizontal deflection. | Permanent horizontal deflection. |
|---|---|---|---|---|---|---|
| | Actual. | Pounds per square inch. | | | | |
| | *Pounds.* | | *Inch.* | *Inch.* | *Inch* | *Inch.* |
| A | 32,950 | 500 | .0540 | 0. | +.10 | 0. |
| B | 32,950 | 500 | .0500 | .0004 | —.09 | 0. |

*Test of the built post.*

Yellow-pine strips, ".32 thick, placed behind north end of stick A; same amount of packing placed behind south end of stick B.

| Loads applied. | Deflections. | | | Remarks. |
|---|---|---|---|---|
| | Horizontal. | Vertical, W. | Vertical, E. | |
| *Pounds.* | *Inch.* | *Inch.* | *Inch.* | |
| 10,000 | 0. | 0. | 0. | |
| 20,000 | —.03 | —.01 | ..... | |
| 30,000 | —.08 | —.04 | .07 | Washers of end bolts are drawn into the wood about $\frac{1}{16}$". South end of stick A takes a bearing. North end of stick B takes a bearing. |
| 40,000 | —.11 | —.08 | ..... | |
| 50,000 | —.06 | —.06 | ..... | |
| 60,000 | —.02 | —.05 | ..... | |
| 70,000 | —.01 | —.05 | ..... | |
| 80,000 | —.01 | —.05 | ..... | |
| 90,000 | —.01 | —.05 | ..... | |
| 100,000 | —.01 | —.05 | .08 | |
| 120,000 | —.04 | —.02 | ..... | |
| 140,000 | —.05 | —.01 | ..... | |
| 160,000 | —.07 | —.01 | ..... | |
| 180,000 | —.08 | 0. | ..... | |
| 200,000 | —.10 | 0. | .05 | |
| 220,000 | —.11 | 0. | ..... | |
| 240,000 | —.12 | 0. | ..... | |
| 260,000 | —.13 | 0. | ..... | |
| 280,000 | —.15 | 0. | ..... | |
| 300,000 | —.19 | 0. | .05 | |
| 320,000 | —.21 | 0. | ..... | |
| 340,000 | —.29 | 0. | ..... | |
| 360,000 | —.37 | 0. | ..... | |
| 380,000 | —.52 | 0. | ..... | |
| 388,000 | —1.08 | —.02 | ..... | Ultimate strength = 2,944 pounds per square inch. |

Failed by horizontal deflection, minus direction.

Deflections increased to 2".50 horizontal.

Stick B failed at the end notches in a similar manner to sketches showing failure of post No. 661.

Stick A crushed fibers at a knot $1\frac{3}{4}$" diameter, 15" from south end.



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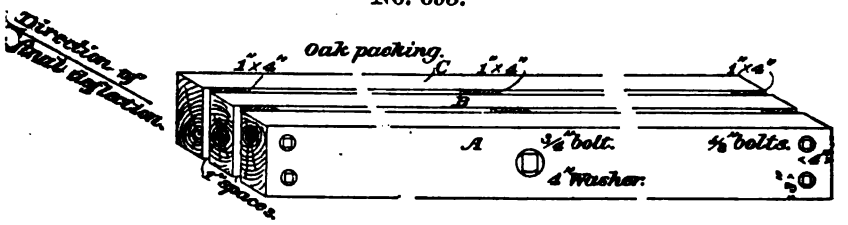
No. 693.




*Preliminary test of the single sticks.*

| Stick. | Weight. | Rings per inch. | Total length. | Width. | Depth. | Sectional area. | Ganged length. |
|---|---|---|---|---|---|---|---|
| | *Pounds.* | | *Inches.* | *Inches.* | *Inches.* | *Sq. inches.* | *Inches.* |
| A | 242 | 11 | 179.97 | 4.50 | 11.61 | 52.2 | 150 |
| B | 276 | 15 | 179.97 | 4.50 | 11.56 | 68.6 | 150 |
| C | 256 | 23 | 179.97 | 4.49 | 11.62 | 52.2 | 150 |
| | 774 | ..... | ..... | ..... | ..... | 168.0 | ..... |

| Stick. | Loads applied. | | Compression. | Compression set. | Horizontal deflection. | Permanent horizontal deflection. |
|---|---|---|---|---|---|---|
| | Actual. | Pounds per inch. | | | | |
| | *Pounds.* | | *Inch.* | *Inch.* | *Inch.* | *Inch.* |
| A | 26,100 | 500 | .0320 | .0002 | 0.05 | 0. |
| B | 31,800 | 500 | .0325 | 0. | .10 | .01 |
| C | 26,100 | 500 | .0148 | —.0005 | .01 | 0. |

*Test of the built post.*

| Loads applied. | Deflections. | | | Remarks. |
|---|---|---|---|---|
| | Horizontal. | Vertical, W. | Vertical, E. | |
| *Pounds.* | *Inch.* | *Inch.* | *Inch.* | |
| 0 | 0. | 0. | 0. | |
| 20,000 | .01 | —.02 | ..... | |
| 40,000 | .01 | —.03 | ..... | |
| 80,000 | .01 | —.03 | ..... | |
| 100,000 | .01 | —.03 | .10 | |
| 140,000 | .01 | —.03 | ..... | |
| 180,000 | .01 | —.03 | ..... | |
| 200,000 | .02 | —.03 | .14 | |
| 240,000 | .02 | —.03 | ..... | |
| 280,000 | .02 | —.03 | ..... | |
| 300,000 | .03 | —.04 | .15 | |
| 340,000 | .05 | —.04 | ..... | |
| 380,000 | .06 | —.04 | ..... | |
| 400,000 | .07 | —.05 | ..... | |
| 440,000 | .09 | —.05 | ..... | |
| 480,000 | .11 | —.05 | ..... | |
| 500,000 | .16 | —.05 | .19 | |
| 520,000 | .20 | —.06 | ..... | |
| 540,000 | .28 | —.06 | ..... | |
| 560,000 | .44 | —.06 | ..... | |
| 564,000 | .90 | —.06 | ..... | Ultimate strength = 3,357 pounds per square inch. |

**Failed by horizontal deflection, plus direction.**

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## No. 694.

Same style of post as No. 693.

*Preliminary test of the single sticks.*

| Stick. | Weight. | Rings per inch. | Total length. | Width. | Depth. | Sectional area. | Gauged length. |
|---|---|---|---|---|---|---|---|
| | *Pounds.* | | *Inches.* | *Inches.* | *Inches.* | *Sq. inches.* | *Inches.* |
| A | 198 | 17 | 180 | 4.50 | 11.35 | 51.1 | 150 |
| B | 290 | 24 | 180 | 5.59 | 11.36 | 63.5 | 150 |
| C | 208 | 10 | 180 | 4.46 | 11.35 | 50.6 | 150 |
| | 691 | ..... | ..... | ..... | ..... | 165.2 | ..... |

| Stick. | Loads applied. | | Compression. | Compression set. | Horizontal deflection. | Permanent horizontal deflection. |
|---|---|---|---|---|---|---|
| | Actual. | Pounds per square inch. | | | | |
| | *Pounds.* | | *Inch.* | *Inch.* | *Inch.* | *Inch.* |
| A | 25,550 | 500 | .0560 | 0. | .18 | .01 |
| B | 31,750 | 500 | .0650 | .0003 | .09 | .02 |
| C | 25,300 | 500 | .0610 | .0005 | 0. | 0. |

*Test of the built post.*

| Loads applied. | Deflections. | | | Remarks. |
|---|---|---|---|---|
| | Horizontal. | Vertical, W. | Vertical, E. | |
| *Pounds.* | *Inch.* | *Inch.* | *Inch.* | |
| 0 | 0. | 0. | 0. | |
| 20,000 | .04 | 0. | ..... | |
| 40,000 | .04 | 0. | ..... | |
| 80,000 | .05 | .02 | ..... | |
| 100,000 | .05 | .03 | —.12 | |
| 140,000 | .05 | .04 | ..... | |
| 180,000 | .05 | .05 | ..... | |
| 200,000 | .05 | .05 | —.13 | |
| 240,000 | .05 | .05 | ..... | |
| 280,000 | .04 | .06 | ..... | |
| 300,000 | .04 | .07 | —.15 | |
| 340,000 | .04 | .07 | ..... | |
| 380,000 | .04 | .08 | ..... | |
| 400,000 | .03 | .09 | —.15 | |
| 440,000 | .01 | .10 | ..... | |
| 480,000 | —.03 | .10 | ..... | |
| 500,000 | —.10 | .10 | —.17 | Ultimate strength = 3,027 per square inch. |

Failed by deflecting horizontally, minus direction.

Horizontal deflection increased to —2″ without crushing fibers of wood or developing any local weakness.

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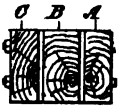
## No. 695.

Same style of post as No. 693.




*Preliminary test of the single sticks.*

| Stick. | Weight. | Rings per inch. | Total length. | Width. | Depth. | Sectional area. | Gauged length. |
|---|---|---|---|---|---|---|---|
| | *Pounds.* | | *Inches.* | *Inches.* | *Inches.* | *Sq. inches.* | *Inches.* |
| A | 207 | 8 | 180 | 4.49 | 11.35 | 51.0 | 150 |
| B | 290 | 16 | 180 | 5.20 | 11.34 | 59.0 | 150 |
| C | 246 | 16 | 180 | 4.50 | 11.35 | 51.1 | 150 |
| | 743 | ..... | ..... | ..... | ..... | 161.1 | ..... |

| Stick. | Loads applied. | | Compression. | Compression set. | Horizontal deflection. | Permanent horizontal deflection. |
|---|---|---|---|---|---|---|
| | Actual. | Pounds per square inch. | | | | |
| | *Pounds.* | | *Inch.* | *Inch.* | *Inch.* | *Inch.* |
| A | 25,500 | 500 | .0429 | .0002 | —.01 | 0. |
| B | 29,500 | 500 | .0290 | .0004 | —.06 | 0. |
| C | 25,550 | 500 | .0410 | .0001 | 0. | 0. |

*Test of the built post.*

| Loads applied. | Deflections. | | | Remarks. |
|---|---|---|---|---|
| | Horizontal. | Vertical, W. | Vertical, E. | |
| *Pounds.* | *Inch.* | *Inch.* | *Inch.* | |
| 0 | 0. | 0. | 0. | Stick B, "shaky"; has longitudinal seams. Stick C has dull, dead appearance in places. |
| 20,000 | 0. | .02 | ..... | |
| 40,000 | 0. | .02 | ..... | |
| 80,000 | —.01 | .02 | ..... | |
| 100,000 | —.01 | .02 | .02 | |
| 140,000 | —.01 | .04 | ..... | |
| 180,000 | —.01 | .05 | ..... | |
| 200,000 | —.01 | .06 | .02 | |
| 240,000 | —.01 | .07 | ..... | |
| 280,000 | —.01 | .10 | ..... | |
| 300,000 | —.01 | .10 | .02 | |
| 340,000 | —.01 | .12 | ..... | |
| 360,000 | —.01 | .12 | ..... | |
| 380,000 | —.01 | .14 | ..... | |
| 400,000 | —.03 | .16 | .04 | |
| 420,000 | —.03 | .18 | ..... | |
| 440,000 | —.05 | .19 | ..... | |
| 460,000 | —.07 | .20 | ..... | |
| 474,000 | ..... | ..... | ..... | Ultimate strength = 2,942 pounds per square inch. |

Stick B failed by opening longitudinal seams.

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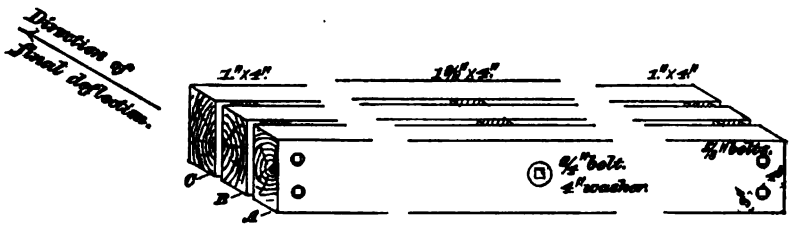
## No. 696.

## SWELLED POST.




*Preliminary test of the single sticks.*

| Stick. | Weight. | Rings per inch. | Total length. | Width. | Depth. | Sectional area. | Gauged length. |
|---|---|---|---|---|---|---|---|
| | *Pounds.* | | *Inches.* | *Inches.* | *Inches.* | *Sq. inches.* | *Inches.* |
| A | 217 | 25 | 180 | 4.51 | 11.24 | 50.7 | 150 |
| B | 253 | 11 | 180 | 5.50 | 11.23 | 61.8 | 150 |
| C | 190 | 15 | 180 | 4.48 | 11.23 | 50.3 | 150 |
| | 660 | ..... | ..... | ..... | ..... | 162.8 | ..... |

| Stick. | Loads applied. | | Compression. | Compression set. | Horizontal deflection. | Permanent horizontal deflection. |
|---|---|---|---|---|---|---|
| | Actual. | Pounds per square inch. | | | | |
| | *Pounds.* | | *Inch.* | *Inch.* | *Inch.* | *Inch.* |
| A | 25,350 | 500 | .0337 | 0. | .08 | .02 |
| B | 30,900 | 500 | .0567 | .0003 | — .05 | 0. |
| C | 25,150 | 500 | .0715 | .0010 | .24 | .03 |

*Test of the built post.*

| Loads applied. | Deflections. | | | Remarks. |
|---|---|---|---|---|
| | Horizontal. | Vertical, W. | Vertical, E. | |
| *Pounds.* | *Inch.* | *Inch.* | *Inch.* | |
| 0 | 0. | 0. | 0. | |
| 20,000 | .02 | 0. | ..... | |
| 40,000 | .02 | 0. | ..... | |
| 80,000 | .05 | .04 | ..... | |
| 100,000 | .05 | .05 | — .10 | |
| 140,000 | .09 | .09 | ..... | |
| 180,000 | .09 | .10 | ..... | |
| 200,000 | .09 | .10 | — .10 | |
| 240,000 | .09 | .11 | ..... | |
| 280,000 | .09 | .12 | ..... | |
| 300,000 | .09 | .13 | — .10 | |
| 340,000 | .09 | .14 | ..... | |
| 380,000 | .09 | .16 | ..... | |
| 400,000 | .09 | .16 | — .15 | |
| 440,000 | .10 | .17 | ..... | |
| 480,000 | .30 | .18 | ..... | Ultimate strength = 2,948 pounds per square inch. |

Failed by horizontal deflection plus direction. Horizontal deflection increased to 2″ without developing any local weakness.

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## No. 697.

Same style of post as No. 696.

*Preliminary test of the single sticks.*

| Stick. | Weight. | Rings per inch. | Total length. | Width. | Depth. | Sectional area. | Gauged length. |
|---|---|---|---|---|---|---|---|
| | *Pounds.* | | *Inches.* | *Inches.* | *Inches.* | *Sq. inches.* | *Inches.* |
| A | 242 | 15 | 180 | 4.52 | 11.60 | 52.4 | 150 |
| B | 249 | 12 | 180 | 5.43 | 11.60 | 63.0 | 150 |
| C | 215 | 15 | 180 | 4.47 | 11.58 | 51.8 | 150 |
| | 706 | ..... | ..... | ..... | ..... | 167.2 | ..... |

| Stick. | Loads applied. | | Compression. | Compression set. | Horizontal deflection. | Permanent horizontal deflection. |
|---|---|---|---|---|---|---|
| | Actual. | Pounds per square inch. | | | | |
| | *Pounds.* | | *Inch.* | *Inch.* | *Inch.* | *Inch.* |
| A | 26,200 | 500 | .0240 | 0. | —.15 | —.01 |
| B | 31,500 | 500 | .0330 | —.0007 | —.01 | 0. |
| C | 25,900 | 500 | .0336 | 0. | .28 | .02 |

*Test of the built post.*

| Loads applied. | Deflections. | | | Remarks. |
|---|---|---|---|---|
| | Horizontal. | Vertical, W. | Vertical, E. | |
| *Pounds.* | *Inch.* | *Inch.* | *Inch.* | |
| 0. | 0. | 0. | 0. | North end of stick A shaky. |
| 20,000 | 0. | .01 | ..... | |
| 40,000 | 0. | .03 | ..... | |
| 80,000 | 0. | .04 | ..... | |
| 100,000 | 0. | .05 | .05 | |
| 140,000 | 0. | .05 | ..... | |
| 180,000 | 0. | .05 | ..... | |
| 200,000 | 0. | .06 | .06 | |
| 240,000 | 0. | .06 | ..... | |
| 280,000 | 0. | .06 | ..... | |
| 300,000 | 0. | .07 | ..... | |
| 340,000 | 0. | .08 | ..... | |
| 380,000 | .01 | .08 | ..... | |
| 400,000 | .02 | .08 | .11 | |
| 440,000 | .04 | .08 | ..... | |
| 460,000 | .07 | .09 | ..... | |
| 480,000 | .09 | .09 | ..... | |
| 500,000 | .12 | .09 | ..... | |
| 520,000 | .19 | .10 | ..... | |
| 540,000 | .50 | .10 | ..... | Ultimate strength = 3,230 lbs. per square inch. |

Failed by horizontal deflection, plus direction.

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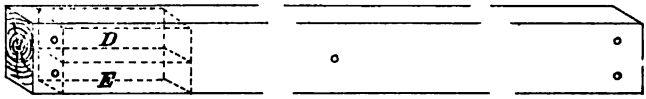
*Test of specimens cut from No. 697, stick A.*




| Specimen. | Weight. | Rings per inch. | Length. | Size. | Sectional area. | Ultimate strength. | | Remarks. |
|---|---|---|---|---|---|---|---|---|
| | | | | | | Actual. | Pounds per square inch. | |
| | *Lbs.* | | *Inches.* | *Inches.* | *Sq. inches.* | *Pounds.* | | |
| D | 7¼ | 6 | 19.95 | 5×3 | 15 | 73,000 | 4,867 | Fibers crushed. |
| E | 7 | 18 | 19.93 | 4.48×3 | 13.44 | 85,600 | 6,369 | Do. |

## No. 698.

Same style of post as No. 696.

1" spaces at ends.
1⅛" " " middle.

*Preliminary test of the single sticks.*

| Stick. | Weight. | Rings per inch. | Total length. | Width. | Depth. | Sectional area. | Gauged length. |
|---|---|---|---|---|---|---|---|
| | *Pounds.* | | *Inches.* | *Inches.* | *Inches.* | *Sq. inches.* | *Inches.* |
| A | 224 | 15 | 179.94 | 4.46 | 11.60 | 51.7 | 150 |
| B | 255 | 8 | 179.94 | 5.53 | 11.70 | 64.7 | 150 |
| C | 296 | 15 | 179.94 | 4.50 | 11.59 | 52.2 | 150 |
| | 775 | ..... | ..... | ..... | ..... | 168.6 | ..... |

| Stick. | Loads applied. | | Compression. | Compression set. | Horizontal deflection. | Permanent horizontal deflection. |
|---|---|---|---|---|---|---|
| | Actual. | Pounds per square inch. | | | | |
| | *Pounds.* | | *Inch.* | *Inch.* | *Inch.* | *Inch.* |
| A | 25,850 | 500 | .0290 | .0009 | —.34 | —.02 |
| B | 32,350 | 500 | .0585 | .0005 | .04 | 0. |
| C | 26,100 | 500 | .0341 | .0004 | .12 | .02 |

*Test of the built post.*

| Loads applied. | Deflections. | | | Remarks. |
|---|---|---|---|---|
| | Horizontal. | Vertical, W. | Vertical, E. | |
| *Pounds.* | *Inch.* | *Inch.* | *Inch.* | |
| 0. | 0. | 0. | 0. | |
| 20,000 | 0. | .02 | ..... | |
| 40,000 | —.01 | .04 | ..... | |
| 80,000 | —.01 | .07 | ..... | |

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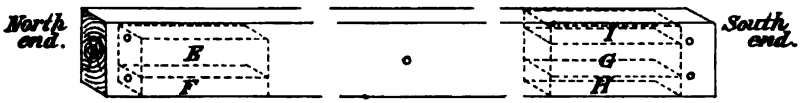
*Test of the built post*—Continued.

| Loads applied. | Deflections. | | | Remarks. |
|---|---|---|---|---|
| | Horizontal. | Vertical, W. | Vertical, E. | |
| *Pounds.* | *Inch.* | *Inch.* | *Inch.* | |
| 100,000 | — .01 | .08 | — .04 | |
| 140,000 | 0. | .09 | ..... | |
| 180,000 | 0. | .09 | ..... | |
| 200,000 | 0. | .09 | — .05 | |
| 240,000 | 0. | .09 | ..... | |
| 280,000 | 0. | .09 | ..... | |
| 300,000 | 0. | .09 | — .07 | |
| 340,000 | — .01 | .09 | ..... | |
| 380,000 | — .02 | .10 | ..... | |
| 400,000 | — .03 | .10 | ..... | |
| 440,000 | — .06 | .10 | ..... | |
| 460,000 | — .08 | .10 | ..... | |
| 480,000 | — .12 | .09 | ..... | |
| 500,000 | — .17 | .09 | — .10 | |
| 510,000 | — .20 | .09 | ..... | |
| 520,000 | — .26 | .09 | ..... | |
| 530,000 | — .33 | .09 | ..... | |
| 540,000 | — .48 | .08 | ..... | |
| 544,000 | — .75 | ..... | ..... | Ultimate strength = 3,227 lbs. per square inch. |

Failed by horizontal deflection, minus direction.
Horizontal deflection increased to 2″.
Sticks taking uniform bend without crushing fibers locally.

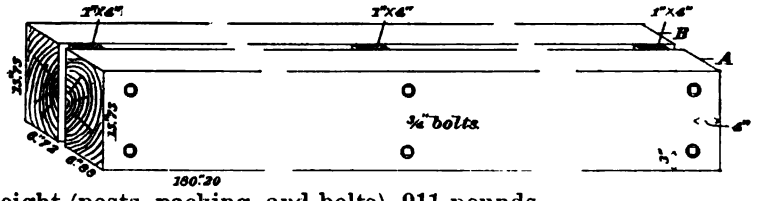
*Test of specimens cut from No. 698, stick C.*




South end of stick as placed in testing machine very resinous.
The rate of growth was most rapid near the heart of the stick.
Specimens E and G have about the same rate of growth, containing the heart; specimens F and H having about the same rate of growth.

| Specimen. | Weight. | Rings per inch. | Length. | Size. | Sectional area. | Ultimate strength. | | Remarks. |
|---|---|---|---|---|---|---|---|---|
| | | | | | | Actual. | Pounds per square inch. | |
| | *Lbs.* | | *In.* | *Inches.* | *Sq. in.* | *Pounds.* | | |
| E | 11 | 11 | 20 | 5.02x4.50 | 22.59 | 123,500 | 5,467 | Fibers crushed. |
| F | 6¾ | 23 | 20 | 3 x4.50 | 13.50 | 86,500 | 6,407 | Do. |
| G | 15½ | 11 | 20 | 5.02x4.50 | 22.59 | 123,800 | 5,480 | Do. |
| H | 11 | 20 | 20 | 3 x4.50 | 13.50 | 79,200 | 5,866 | Do. |
| I | 8¼ | 20 | 20 | 2.75x4.48 | 12.32 | 81,800 | 6,640 | Do. |

No. 488.




Weight (posts, packing, and bolts), 911 pounds.
Sectional area, 108.36; 105.84 = 214.2 square inches.

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Gauged length taken on post A, 160″.
Post free from knots.
Stick A, new timber, has not been previously tested.
Stick B previously tested in built post No. 691.

| Loads applied. | Pounds per square inch. | Compression. | Permanent set. | Deflections. | | Remarks. |
|---|---|---|---|---|---|---|
| | | | | Horizontal. | Vertical. | |
| *Pounds.* | | *Inch.* | *Inch.* | *Inch.* | *Inch.* | |
| 10,000 | | 0. | | 0. | 0. | |
| 50,000 | | .0148 | | 0. | 0. | |
| 10,000 | | | 0. | 0. | 0. | |
| 100,000 | | .0355 | | 0. | 0. | |
| 10,000 | | | 0. | 0. | 0. | |
| 150,000 | | .0560 | | 0. | 0. | |
| 10,000 | | | 0. | 0. | 0. | |
| 200,000 | | .0785 | | −.02 | 0. | |
| 10,000 | | | .0010 | 0. | 0. | |
| 250,000 | | .1008 | | −.05 | 0. | |
| 10,000 | | | .0010 | 0. | 0. | Snapping sounds heard. |
| 300,000 | | .1240 | | −.08 | 0. | |
| 10,000 | | | .0015 | 0. | 0. | |
| 350,000 | | .1480 | | −.10 | 0. | |
| 10,000 | | | .0021 | −.01 | 0. | |
| 400,000 | | .1730 | | −.13 | 0. | |
| 10,000 | | | .0030 | −.02 | 0. | |
| 450,000 | | | | −.17 | .02 | |
| 500,000 | | | | −.20 | .05 | |
| 550,000 | | | | −.28 | .06 | |
| 600,000 | | | | −.34 | .06 | |
| 650,000 | | | | −.45 | .06 | |
| 700,000 | 3,268 | | | −.75 | .06 | Ultimate strength. |
| | | | | −1.50 | .06 | Deflections after sustaining load 6 minutes. |
| 10,000 | | | | −.40 | 0. | |

Longitudinal cracks opened along middle of stick B; no cracks developed in stick A.
Time of test, one hour.

*Compression of yellow-pine posts.*

TABULATED RESULTS.

| Number of test. | Weight. | Average rate of growth. rings per inch. | Size of post. | | | Sectional area. | Ultimate strength. | | Manner of failure. |
|---|---|---|---|---|---|---|---|---|---|
| | | | Length. | Width. | Depth. | | Actual. | Pounds per square inch. | |
| | *Lbs.* | | *Ft. In.* | *In.* | *In.* | *Sq. in.* | *Pounds.* | | |
| 565 | 47 | 20 | 5 .06 | 5.50 | 5.50 | 30.3 | 172,000 | 5,677 | Fibers crushed 12″ from end of post. |
| 566 | 44 | 12 | 5 .10 | 5.50 | 5.49 | 30.2 | 141,000 | 4,669 | Failed at knots 15″ from end. |
| 567 | 45 | 25 | 5 .10 | 5.48 | 5.54 | 30.4 | 168,000 | 5,526 | Failed at knots 9″ and 17″ from end of post. |
| 568 | 47½ | 20 | 5 .10 | 5.46 | 5.50 | 30 | 108,000 | 3,600 | Failed at knot 8″ from end of post. |
| 562 | 72½ | ..... | 7 5.98 | 5.45 | 5.52 | 30.1 | 140,000 | 4,651 | Failed at season-cracks; crushed fibers. |
| 563 | 59½ | ..... | 7 6.14 | 5.46 | 5.46 | 29.8 | 124,000 | 4,161 | Failed at knots 30″ from end of post. |
| 564 | 57 | ..... | 7 6.15 | 5.47 | 5.47 | 29.9 | 143,500 | 4,799 | Failed at knots 27″ from end of post. |
| 559 | 86 | ..... | 10 .17 | 5.49 | 5.48 | 30.1 | 146,200 | 4,857 | Deflected upward. |
| 560 | 88½ | ..... | 10 .16 | 5.50 | 5.47 | 30.1 | 139,000 | 4,618 | Deflected downward. |
| 561 | 110 | ..... | 10 .15 | 5.51 | 5.50 | 30.3 | 143,600 | 4,739 | Failed at knots middle of post. |
| 556 | 126 | ..... | 12 6.12 | 5.54 | 5.51 | 30.5 | 156,000 | 5,114 | Deflected horizontally. |
| 557 | 128 | ..... | 12 6.17 | 5.47 | 5.52 | 30.2 | 156,000 | 5,166 | Deflected diagonally. |
| 558 | 141½ | ..... | 12 6.20 | 5.50 | 5.50 | 30.3 | 150,000 | 4,950 | Do. |

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*Compression of yellow-pine posts*—Continued.

| Number of test. | Weight. | Average rate of growth, rings per inch. | Size of post. | | | Sectional area. | Ultimate strength. | | Manner of failure. |
|---|---|---|---|---|---|---|---|---|---|
| | | | Length. | Width. | Depth. | | Actual. | Pounds per square inch. | |
| | *Lbs.* | | *Ft. In.* | *In.* | *In.* | *Sq. in.* | *Pounds.* | | |
| 553 | 140 | ..... | 15 .22 | 5.50 | 5.48 | 30.1 | 99,200 | 3,296 | Deflected downward. |
| 554 | 148 | ..... | 15 .24 | 5.49 | 5.47 | 30 | 130,000 | 4,333 | Deflected horizontally. |
| 555 | 148 | ..... | 15 .25 | 5.50 | 5.50 | 30.3 | 129,000 | 4,257 | Deflected diagonally. |
| 550 | 172 | ..... | 17 6.24 | 5.48 | 5.47 | 30 | 90,000 | 3,000 | Deflected horizontally. |
| 551 | 180½ | ..... | 17 6.25 | 5.46 | 5.46 | 29.8 | 109,000 | 3,658 | Do. |
| 552 | 167⅛ | ..... | 17 6.26 | 5.50 | 5.50 | 30.3 | 93,000 | 3,069 | Do. |
| 548 | 185 | ..... | 20 .30 | 5.40 | 5.45 | 29.4 | 82,000 | 2,789 | Do. |
| 549 | 185 | ..... | 20 .28 | 5.45 | 5.46 | 29.8 | 87,800 | 2,946 | Do. |
| 545 | 212 | ..... | 22 6.28 | 5.64 | 5.59 | 31.5 | 73,700 | 2,340 | Do. |
| 546 | 189 | ..... | 22 6.37 | 5.42 | 5.49 | 29.8 | 56,000 | 1,879 | Deflected upward. |
| 547 | 266 | ..... | 22 6.30 | 5.65 | 5.61 | 31.7 | 62,500 | 1,972 | Deflected diagonally. |
| 508 | 210 | ..... | 25 .36 | 5.46 | 5.48 | 29.9 | 52,000 | 1,739 | Deflected horizontally. |
| 509 | 235 | ..... | 25 .30 | 5.46 | 5.49 | 30 | 59,000 | 1,967 | Do. |
| 510 | 210 | ..... | 25 .33 | 5.45 | 5.46 | 29.8 | 55,500 | 1,862 | Do. |
| 499 | 258 | ..... | 27 6.44 | 5.31 | 5.29 | 28.1 | 60,800 | 2,163 | Do. |
| 500 | 236 | ..... | 27 6.43 | 5.32 | 5.30 | 28.2 | 39,000 | 1,383 | Deflected diagonally. |
| 501 | 256 | ..... | 27 6.40 | 5.31 | 5.30 | 28.1 | 44,400 | 1,580 | Deflected horizontally. |
| 572 | 124 | 6 | 6 8.10 | 7.78 | 9.75 | 75.8 | 260,000 | 3,430 | Failed at a knot 30″ from end of post. |
| 573 | 131 | 14 | 6 8.08 | 7.76 | 9.77 | 75.8 | 286,500 | 3,780 | Failed at a knot 26″ from end of post. |
| 574 | 161½ | 21 | 6 8.10 | 7.74 | 9.81 | 75.9 | 383,000 | 5,046 | Failed at knots 8″ from end of post. |
| 578 | 233½ | 23 | 10 .13 | 7.74 | 9.73 | 75.3 | 304,000 | 4,037 | Failed at a knot 18″ from end of post. |
| 579 | 240 | 19 | 10 .14 | 7.78 | 9.75 | 75.9 | 399,500 | 5,264 | Failed 36″ from end; grain of wood wavy. |
| 580 | 240 | 28 | 10 .14 | 7.75 | 9.75 | 75.6 | 350,000 | 4,629 | Failed at knot 17″ from end of post. |
| 584 | 266 | 18 | 13 4.18 | 7.68 | 9.72 | 74.6 | 307,500 | 4,122 | Failed at knots 15″ and 29″ from end of post. |
| 585 | 258 | 6 | 13 4.15 | 7.75 | 9.74 | 75.5 | 284,000 | 3,762 | Failed at knots 45″ from end of post. |
| 586 | 336 | 23 | 13 4.20 | 7.75 | 9.75 | 75.6 | 296,000 | 3,921 | Failed at knots near middle of post. |
| 587 | 318 | 24 | 16 8.17 | 7.70 | 9.74 | 75 | 274,500 | 3,660 | Failed at knots 50″ from end of post. |
| 588 | 381 | 12 | 16 8.24 | 7.74 | 9.73 | 75.3 | 382,000 | 5,073 | Deflected horizontally. |
| 589 | 339½ | 21 | 16 8.26 | 7.25 | 9.49 | 68.8 | 304,000 | 4,419 | Do. |
| 530 | 461 | ..... | 20 .25 | 7.71 | 9.80 | 75.6 | 287,000 | 3,796 | Do. |
| 531 | 410 | ..... | 20 .28 | 7.76 | 9.58 | 74.3 | 275,000 | 3,701 | Failed at knots 70″ from end of post. |
| 532 | 391 | ..... | 20 .25 | 7.61 | 9.68 | 73.7 | 220,000 | 2,985 | Deflected horizontally. |
| 542 | 501 | ..... | 23 4.20 | 7.69 | 9.77 | 75.1 | 225,000 | 2,996 | Do. |
| 543 | 501 | ..... | 23 4.20 | 7.69 | 9.73 | 74.8 | 220,500 | 2,948 | Do. |
| 544 | 560 | ..... | 23 4.22 | 7.70 | 9.76 | 75.1 | 298,000 | 3,968 | Do. |
| 527 | 531 | ..... | 26 8.30 | 7.40 | 9.47 | 70 | 210,000 | 3,000 | Do. |
| 528 | 627 | ..... | 26 8.29 | 7.45 | 9.45 | 70.4 | 205,000 | 2,912 | Do. |
| 529 | 535 | ..... | 26 8.30 | 7.46 | 8.94 | 66.7 | 184,500 | 2,766 | Deflected diagonally. |
| 711 | 375 | 12 | 15 .08 | 5.60 | 15.60 | 87.4 | 349,000 | 3,993 | Deflected horizontally. |
| 712 | 397 | 21 | 15 .05 | 5.63 | 15.57 | 87.7 | 339,000 | 3,865 | Do. |
| 713 | 382 | 15 | 15 .00 | 5.65 | 15.50 | 87.6 | 272,500 | 3,111 | Do. |
| 484 | 432 | ..... | 15 .25 | 6.90 | 15.85 | 109.4 | 270,000 | 2,468 | Deflected horizontally; knot on concave side. |
| 708 | 464 | 17 | 15 .00 | 6.61 | 15.51 | 102.5 | 340,000 | 3,317 | Failed at some knots at middle of post. |
| 709 | 557 | 18 | 15 .00 | 6.60 | 15.64 | 103.2 | 455,000 | 4,400 | Deflected horizontally. |
| 710 | 491 | 18 | 14 11.92 | 6.61 | 15.61 | 103.2 | 432,000 | 4,186 | Do. |
| 641 | 561 | 5 | 15 .10 | 8.25 | 16.25 | 134 | 428,000 | 3,194 | Fibers crushed at middle of post, vicinity of knots. |
| 671 | 585 | 12 | 15 .07 | 8.25 | 16.20 | 133.6 | 425,000 | 3,181 | Deflected horizontally. |
| 672 | 578 | 13 | 14 11.93 | 8.20 | 16.20 | 132.8 | 526,000 | 3,961 | Do. |
| 485 | 434 | ..... | 15 .27 | 6.75 | 15.95 | 107.7 | 175,000 | 1,625 | Deflected horizontally; knots on concave side. |
| 487 | 450 | ..... | 15 .25 | 6.80 | 15.72 | 106.9 | 310,000 | 2,900 | Deflected horizontally; initial bend in post. |
| 486 | 705 | ..... | 15 .24 | 8.63 | 16.83 | 145.2 | 380,000 | 2,617 | Opened shakes and season-cracks. |

Second test of these posts.

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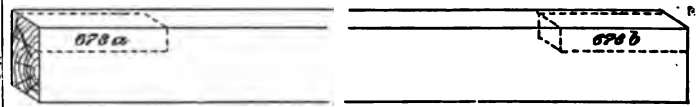
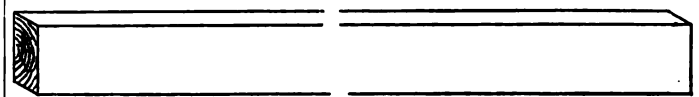
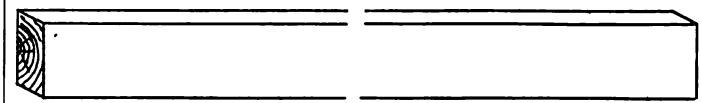
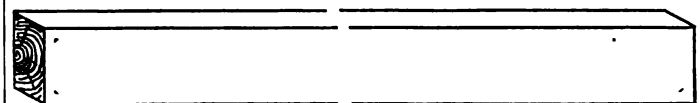
## *Compression of yellow pine—Single sticks and built posts.*

TABULATED RESULTS.

| Number of test. | Kind of post. | Weight. | Average rate of growth. Rings per inch. | Dimensions of post. | | | Sectional area. | Compression in 150 inches. Load of 500 pounds per square inch. | Ultimate strength. | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Length. | Width. | Depth. | | | Actual. | Pounds per square inch. |
| | | *Pounds.* | | *Inches.* | *Inches.* | *Inches.* | *Sq. inches.* | *Inch.* | *Pounds.* | |
| 673 |   | 260 | 11 | 180.05 | 4.09 | 11.35 | 46.04 | .0370 | 142,200 | 3,065 |
| 673a | | 13 | | 20 | 4.01 | 4.01 | 16.08 | | 94,000 | 5,846 |
| 673b | | 7¼ | | 20 | 3.95 | 3.97 | 15.68 | | 99,600 | 6,352 |
| 674 |  | 233 | 17 | 180 | 4.51 | 11.60 | 52.3 | .0492 | 131,500 | 2,515 |
| 675 |  | 194 | 22 | 180 | 4.34 | 11.60 | 50.3 | .0490 | 121,200 | 2,410 |
| 490 |  | 269 | ..... | 180 | 5.05 | 12.10 | 61.1 | ..... | 230,000 | 3,764 |

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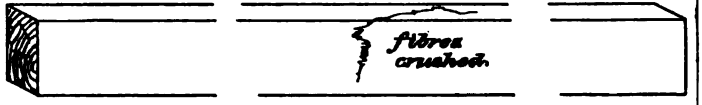
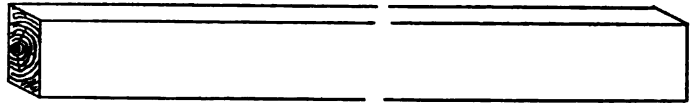
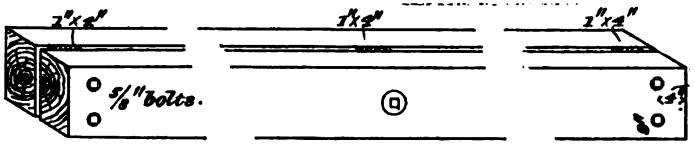
## *Compression of yellow pine—single sticks and built posts*—Continued.

| Number of test. | Kind of post. | Weight. | Average rate of growth. Rings per inch. | Dimensions of post. Length. | Width. | Depth. | Sectional area. | Compression in 150 inches. Load of 500 pounds per square inch. | Ultimate strength. Actual. | Pounds per square inch. |
|---|---|---|---|---|---|---|---|---|---|---|
| | | *Pounds.* | | *Inches.* | *Inches.* | *Inches.* | *Sq. inches.* | *Inch.* | *Pounds.* | |
| 670 |   | 309 | 12 | 180 | 5.65 | 11.74 | 66.3 | .0455 | 205,900 | 3,106 |
| 480 |  | 287 | ..... | 180.08 | 5.85 | 12.05 | 70.5 | ..... | 250,000 | 3,546 |
| 654 |   | 326<br>290 } 616 | 11<br>6 | 180<br>180 | 5.63<br>5.62 | 11.71<br>11.71 | 65.9<br>65.9 } 131.8 | .0418<br>.0540 | 470,000 | 3,566 |
| 655 | Same style as No. 654 | 292<br>329 } 621 | 34<br>24 | 179.93<br>179.96 | 5.64<br>5.63 | 11.72<br>11.72 | 66.1<br>66.1 } 132.2 | .0292<br>.0315 | 580,000 | 4,387 |
| 656 | Same style as No. 654 | 282<br>287 } 569 | 13<br>11 | 180<br>180 | 5.61<br>5.61 | 11.71<br>11.71 | 65.7<br>65.7 } 131.4 | .0368<br>.0466 | 480,000 | 3,653 |

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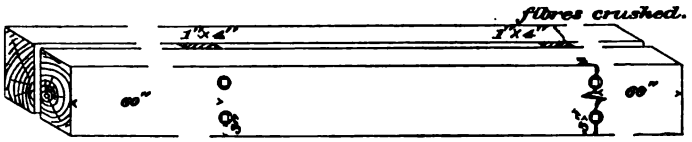
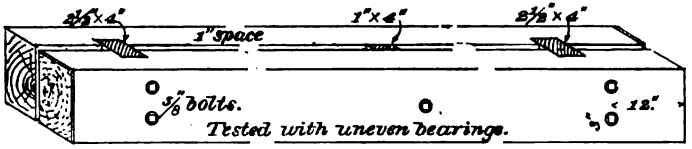
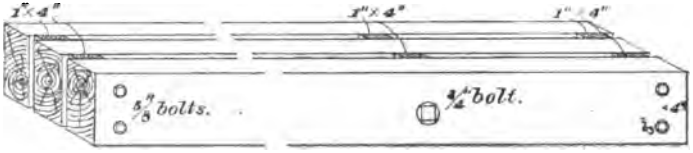
| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 651 | Same as No. 654, except swelled ¾″ at middle | 262<br>275 | 537 | 11<br>7 | 180<br>180 | 5.58<br>5.58 | 11.71<br>11.71 | 65.3<br>65.3 | 130.6 | .0620<br>.0514 | 360,000 | 2,756 |
| 652 | Same as No. 654, except swelled ¾″ at middle | 310<br>370 | 680 | 16<br>16 | 180<br>180 | 5.58<br>5.58 | 11.70<br>11.71 | 65.3<br>65.3 | 130.6 | .0395<br>.0360 | 588,500 | 4,506 |
| 653 | Same as No. 654, except swelled ¾″ at middle | 310<br>311 | 621 | 16<br>12 | 180<br>180 | 5.63<br>5.59 | 11.71<br>11.68 | 65.9<br>65.3 | 131.2 | .0559<br>.0550 | 436,600 | 3,328 |
| 657 |  | 340<br>319 | 659 | 9<br>13 | 179.96<br>179.96 | 5.63<br>5.64 | 11.72<br>11.71 | 66.0<br>66.0 | 132.0 | .0375<br>.0305 | 580,000 | 4,394 |
| 658 | Same style as No. 657 | 319<br>332 | 651 | 12<br>9 | 179.98<br>179.98 | 5.59<br>5.59 | 11.71<br>11.72 | 65.5<br>65.5 | 131.0 | .0320<br>.0436 | 448,000 | 3,420 |
| 659 | Same style as No. 657 | 320<br>293 | 613 | 12<br>8 | 180<br>180 | 5.61<br>5.61 | 11.73<br>11.73 | 65.8<br>65.8 | 131.6 | .0312<br>.0372 | 600,000 | 4,559 |
| 660 |  | 283<br>294 | 577 | 25<br>18 | 180.03<br>180.03 | 5.61<br>5.63 | 11.22<br>11.24 | 62.9<br>63.3 | 126.2 | .0325<br>.0400 | 510,000 | 4,041 |
| 661 | Same style as No. 660. Tested with uneven bearings | 274<br>310 | 584 | 12<br>9 | 180<br>180 | 5.66<br>5.60 | 11.70<br>11.72 | 66.2<br>65.6 | 131.8 | .0410<br>.0365 | 410,000 | 3,111 |
| 662 | Same style as No. 660. Tested with uneven bearings | 292<br>280 | 572 | 14<br>8 | 180<br>180 | 5.61<br>5.61 | 11.75<br>11.75 | 65.9<br>65.9 | 131.8 | .0340<br>.0500 | 388,000 | 2,944 |
| 693 |  | 242<br>276<br>256 | 774 | 11<br>15<br>23 | 179.97<br>179.97<br>179.97 | 4.50<br>5.50<br>4.49 | 11.61<br>11.56<br>11.62 | 52.2<br>63.6<br>52.2 | 168.0 | .0320<br>.0325<br>.0148 | 564,000 | 3,357 |

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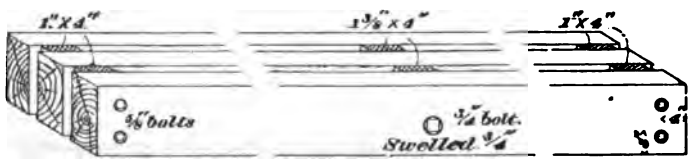
## *Compression of yellow pine—single sticks and built posts*—Continued.

| Number of test. | Kind of post. | Weight. | Average rate of growth. Rings per inch. | Dimensions of post. Length. | Width. | Depth. | Sectional area. | Compression in 150 inches. Load of 500 pounds per square inch. | Ultimate strength. Actual. | Pounds per square inch. |
|---|---|---|---|---|---|---|---|---|---|---|
| | | *Pounds.* | | *Inches.* | *Inches.* | *Inches.* | *Sq. inches.* | *Inch.* | *Pounds.* | |
| 694 | Same style as No. 693 | 193<br>290<br>208 — 691 | 17<br>24<br>10 | 180<br>180<br>180 | 4.50<br>5.59<br>4.46 | 11.35<br>11.36<br>11.35 | 51.1<br>63.5<br>50.6 — 165.2 | .0500<br>.0650<br>.0610 | 500,000 | 3,027 |
| 695 | Same style as No. 693 | 207<br>290<br>246 — 743 | 8<br>16<br>16 | 180<br>180<br>180 | 4.49<br>5.20<br>4.50 | 11.35<br>11.34<br>11.35 | 51.0<br>59.0<br>51.1 — 161.1 | .0429<br>.0290<br>.0410 | 474,000 | 2,942 |
| 696 |  | 217<br>253<br>190 — 660 | 25<br>11<br>15 | 180<br>180<br>180 | 4.51<br>5.50<br>4.48 | 11.24<br>11.23<br>11.23 | 50.7<br>61.8<br>50.3 — 162.8 | .0337<br>.0567<br>.0715 | 480,000 | 2,948 |
| 697 | Same style as No. 696 | 242<br>249<br>215 — 706 | 15<br>12<br>15 | 180<br>180<br>180 | 4.52<br>5.43<br>4.47 | 11.60<br>11.60<br>11.58 | 52.4<br>63.0<br>51.8 — 167.2 | .0240<br>.0330<br>.0336 | 540,000 | 3,230 |

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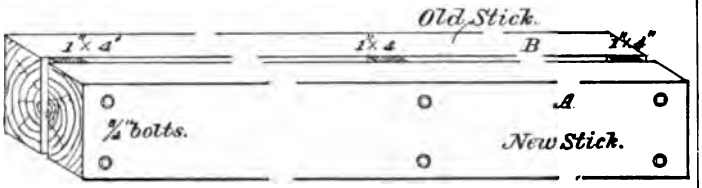
| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 698 | Same style as No. 696 | 224<br>255<br>296 } 775 | 15<br>8<br>15 | 179.94<br>179.94<br>179.94 | 4.46<br>5.53<br>4.50 | 11.60<br>11.70<br>11.59 | 51.7<br>64.7<br>52.2 } 168.6 | .0290<br>.0585<br>.0341 | 544,000 | 3,227 |
| 488 |  | 911 | ..... | 180.20 | 6.88<br>6.72 | 15.75<br>15.75 | 108.36<br>105.84 } 214.2 | ..... | 700,000 | 3,268 |

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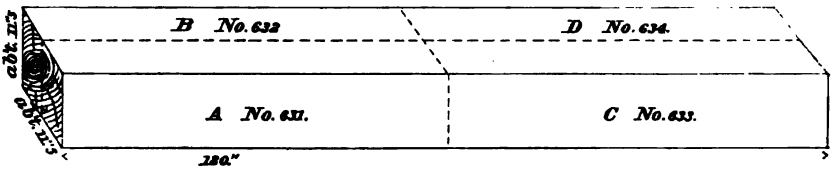
THOROUGHLY SEASONED YELLOW-PINE POST FROM THE ARSENAL STOREHOUSE.

TIME TESTS.



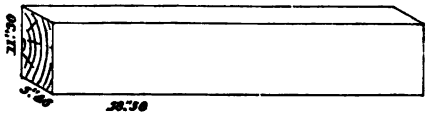

Yellow-pine post about 11″.5 square by 10 feet long, cut into four specimens—A, B, C, and D.

Specimens A and D tested by gradually increasing the compression loads till failure took place.

Specimens B and C tested by applying increments of 200 pounds per square inch compression, allowing each increment to remain five minutes; measuring the compression when first applied and again at the end of five minutes, then releasing the strains to zero-load, measuring the compression set immediately and again after five minutes' rest; so proceeding to the end of the test.

No. 631.

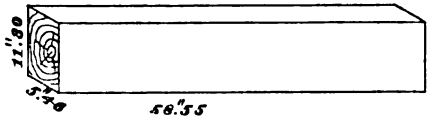
SPECIMEN A.



Sectional area, 61.7 square inches.
Weight, 86½ pounds.
Average rate of growth, 9 rings per inch.
Ultimate strength, 422,000 pounds = 6,840 pounds per square inch.
Time of test, 14 minutes.
Deflected sideways, crushing fibers on the concave side.

No. 632.

SPECIMEN B.



Sectional area, 61.7 square inches.
Weight, 85 pounds.
Gauged length, 30″.

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| Loads applied. | Pounds per square inch. | Compression | Compression set. | Remarks. |
|---|---|---|---|---|
| *Pounds.* | | *Inch.* | *Inch.* | |
| 0 | 0 | 0. | | |
| 12,340 | 200 | 0. | | |
| | | 0. | | |
| | 0 | | — .0005 | |
| | | | — .0005 | |
| 24,680 | 400 | .0022 | | |
| | | .0024 | | |
| | 0 | | — .0008 | |
| | | | — .0006 | |
| 37,020 | 600 | .0050 | | |
| | | .0052 | | |
| | 0 | | — .0006 | |
| | | | — .0008 | |
| 49,360 | 800 | .0078 | | |
| | | .0079 | | |
| | 0 | | —. 0006 | |
| | | | —. 0006 | |
| 61,700 | 1,000 | .0108 | | |
| | | .0110 | | |
| | 0 | | — .0004 | |
| | | | — .0008 | |
| 74,040 | 1,200 | .0137 | | |
| | | .0139 | | |
| | 0 | | — .0005 | |
| | | | — .0008 | |
| 86,380 | 1,400 | .0164 | | |
| | | .0166 | | |
| | 0 | | — .0006 | |
| | | | — .0008 | |
| 98,720 | 1,600 | .0191 | | |
| | | .0194 | | |
| | 0 | | — .0005 | |
| | | | — .0005 | |
| 111,060 | 1,800 | .0219 | | |
| | | .0221 | | |
| | 0 | | — .0004 | |
| | | | — .0005 | |
| 123,400 | 2,000 | .0248 | | |
| | | .0249 | | |
| | 0 | | — .0002 | |
| | | | — .0003 | |
| | | | 0. | Rested over night 15 hours. |
| 135,740 | 2,200 | .0270 | | |
| | | .0275 | | |
| | 0 | | 0. | |
| | | | 0. | |
| 148,080 | 2,400 | .0300 | | |
| | | .0301 | | |
| | 0 | | .0003 | |
| | | | .0002 | |
| 160,420 | 2,600 | .0326 | | |
| | | .0330 | | |
| | 0 | | .0005 | |
| | | | .0005 | |
| 172,760 | 2,800 | .0358 | | |
| | | .0360 | | |
| | 0 | | .0009 | |
| | | | .0005 | |
| 185,100 | 3,000 | .0388 | | |
| | | .0393 | | |
| | 0 | | .0010 | |
| | | | .0009 | |
| 197,440 | 3,200 | .0420 | | |
| | | .0424 | | |
| | 0 | | .0011 | |
| | | | .0010 | |
| 209,780 | 3,400 | .0449 | | |
| | | .0453 | | |
| | 0 | | .0015 | |
| | | | .0011 | |
| 222,120 | 3,600 | .0478 | | |
| | | .0483 | | |
| | 0 | | .0019 | |
| | | | .0015 | |
| 234,460 | 3,800 | .0509 | | |
| | | .0513 | | |
| | 0 | | .0018 | |
| | | | .0016 | |
| 246,800 | 4,000 | .0539 | | |
| | | .0546 | | |



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| Loads applied. | Pounds per square inch. | Compression. | Compression set. | Remarks. |
|---|---|---|---|---|
| *Pounds.* | | *Inch.* | *Inch.* | |
| | 0 | | .0024 | |
| | | | .0020 | |
| 259,140 | 4,200 | .0570 | | |
| | | .0576 | | |
| | 0 | | .0025 | |
| | | | .0020 | |
| 271,480 | 4,400 | .0600 | | |
| | | .0607 | | |
| | 0 | | .0030 | |
| | | | .0025 | |
| 283,820 | 4,600 | .0634 | | |
| | | .0646 | | |
| | 0 | | .0035 | |
| | | | .0030 | |
| 296,160 | 4,800 | .0670 | | |
| | | .0682 | | |
| | 0 | | .0044 | |
| | | | .0035 | |
| 308,500 | 5,000 | .0702 | | |
| | | .0720 | | |
| | 0 | | .0050 | |
| | | | .0042 | |
| 320,840 | 5,200 | .0742 | | |
| | | .0762 | | |
| | 0 | | .0060 | |
| | | | .0052 | |
| 333,180 | 5,400 | .0785 | | |
| | | .0810 | | |
| | 0 | | .0075 | |
| | | | .0063 | |
| 345,520 | 5,600 | .0830 | | |
| | | .0870 | | |
| | 0 | | .0089 | |
| | | | .0080 | |
| 357,860 | 5,800 | .0891 | | |
| | | .0941 | | |
| | 0. | | .0114 | |
| | | | .0097 | |
| 370,200 | 6,000 | .0965 | | |
| | | .1008 | | |
| | 0 | | .0133 | |
| | | | .0115 | |
| 382,540 | 6,200 | .1030 | | Ultimate strength. |

Crushed fibers 12″ from end at a knot.

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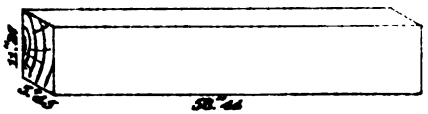
## No. 633.

### SPECIMEN C.



**Sectional area, 61.4 square inches.**
**Weight, 86 pounds.**
**Gauged length, 30″.**

| Loads applied. | Pounds per square inch. | Compression. | Compression set. | Remarks. |
|---|---|---|---|---|
| *Pounds.* | | *Inch.* | *Inch.* | |
| 0 | 0 | 0. | | |
| 12,280 | 200 | .0024 | | |
| | | .0024 | | |
| | 0 | | .0006 | |
| | | | .0008 | |
| 24,560 | 400 | .0052 | | |
| | | .0052 | | |
| | 0 | | .0007 | |
| | | | .0005 | |
| 36,840 | 600 | .0079 | | |
| | | .0080 | | |
| | 0 | | .0009 | |
| | | | .0005 | |
| 49,120 | 800 | .0106 | | |
| | | .0112 | | |
| | 0 | | .0008 | |
| | | | .0005 | |
| 61,400 | 1,000 | .0139 | | |
| | | .0140 | | |
| | 0 | | .0006 | |
| | | | .0006 | |
| 73,680 | 1,200 | .0169 | | |
| | | .0171 | | |
| | 0 | | .0009 | |
| | | | .0010 | |
| 85,960 | 1,400 | .0197 | | |
| | | .0199 | | |
| | 0 | | .0010 | |
| | | | .0009 | |
| 98,240 | 1,600 | .0227 | | |
| | | .0230 | | |
| | 0 | | .0011 | |
| | | | .0010 | |
| 110,520 | 1,800 | .0258 | | |
| | | .0259 | | |
| | 0 | | .0013 | |
| | | | .0010 | |
| 122,800 | 2,000 | .0284 | | |
| | | .0289 | | |
| | 0 | | .0011 | |
| | | | .0010 | |
| 135,080 | 2,200 | .0315 | | |
| | | .0318 | | |
| | 0 | | .0013 | |
| | | | .0010 | |
| 147,360 | 2,400 | .0347 | | |
| | | .0350 | | |
| | 0 | | .0015 | |
| | | | .0011 | Rested 30 minutes without further recovery. |
| 159,640 | 2,600 | .0377 | | |
| | | .0381 | | |
| | 0 | | .0018 | |
| | | | .0015 | |
| 171,920 | 2,800 | .0410 | | |
| | | .0410 | | |
| | 0 | | .0020 | |
| | | | .0016 | |
| 184,200 | 3,000 | .0440 | | |
| | | .0445 | | |

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| Loads applied. | Pounds per square inch. | Compression. | Compression set. | Remarks. |
|---|---|---|---|---|
| *Pounds.* | | *Inch.* | *Inch.* | |
| | 0 | | .0020 | |
| | | | .0020 | |
| 196, 480 | 3, 200 | .0470 | | |
| | | .0477 | | |
| | 0 | | .0025 | |
| | | | .0020 | |
| 208, 760 | 3, 400 | .0500 | | |
| | | .0505 | | |
| | 0 | | .0030 | |
| | | | .0021 | |
| 221, 040 | 3, 600 | .0535 | | |
| | | .0540 | | |
| | 0 | | .0030 | |
| | | | .0029 | |
| 233, 320 | 3, 800 | .0564 | | |
| | | .0572 | | |
| | 0 | | .0037 | |
| | | | .0030 | |
| 245, 600 | 4, 000 | .0599 | | |
| | | .0610 | | |
| | 0 | | .0040 | |
| | | | .0036 | |
| 257, 880 | 4, 200 | .0634 | | |
| | | .0640 | | |
| | 0 | | .0044 | |
| | | | .0040 | |
| 270, 160 | 4, 400 | .0664 | | |
| | | .0675 | | |
| | 0 | | .0050 | Rested over night 15 hours. |
| | | | .0043 | |
| | | | .0032 | |
| 282, 440 | 4, 600 | .0691 | | |
| | | .0707 | | |
| | 0 | | .0053 | |
| | | | .0049 | |
| 294, 720 | 4, 800 | .0730 | | |
| | | .0739 | | |
| | 0 | | .0063 | |
| | | | .0052 | |
| 307, 000 | 5, 000 | .0764 | | |
| | | .0780 | | |
| | 0 | | .0070 | |
| | | | .0062 | |
| 319, 280 | 5, 200 | .0810 | | |
| | | .0825 | | |
| | 0 | | .0080 | |
| | | | .0070 | |
| 331, 560 | 5, 400 | .0850 | | |
| | | .0875 | | |
| | 0 | | .0095 | |
| | | | .0085 | |
| 343, 840 | 5, 600 | .0898 | | |
| | | .0931 | | |
| | 0 | | .0115 | |
| | | | .0101 | |
| 356, 120 | 5, 800 | .0958 | | |
| | | .0995 | | |
| | 0 | | .0138 | |
| | | | .0121 | |
| 368, 400 | 6, 000 | .1025 | | |
| | | .1074 | | |
| | 0 | | .0167 | |
| | | | .0149 | |
| 380, 680 | 6, 200 | .1125 | | |
| | | .1194 | | |
| | 0 | | .0210 | |
| | | | .0192 | |
| 392, 960 | 6, 400 | .1234 | | |
| | | .1335 | | |
| | 0 | | .0280 | |
| | | | .0250 | |
| 405, 240 | 6, 600 | .1357 | | Ultimate strength. |

Fibers crushed 16″ from end of specimen, which took a slight deflection sideways.

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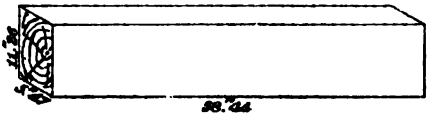
## No. 634.

### SPECIMEN D.



**Sectional area, 61. 6 square inches.**
**Weight, 88½ pounds.**
**Gauged length, 30″.**

| Loads applied. | Pounds per square inch. | Compression. | Remarks. |
|---|---|---|---|
| *Pounds.* | | *Inch.* | |
| 0 | 0 | 0. | |
| 12, 320 | 200 | .0040 | |
| 24, 640 | 400 | .0075 | |
| 36, 960 | 600 | .0108 | |
| 49, 280 | 800 | .0134 | |
| 61, 600 | 1, 000 | .0159 | |
| 73, 920 | 1, 200 | .0185 | |
| 86, 240 | 1, 400 | .0214 | |
| 98, 560 | 1, 600 | .0240 | |
| 110, 880 | 1, 800 | .0268 | |
| 123, 200 | 2, 000 | .0292 | |
| 135, 520 | 2, 200 | .0320 | |
| 147, 840 | 2, 400 | .0348 | |
| 160, 160 | 2, 600 | .0375 | |
| 172, 480 | 2, 800 | .0404 | |
| 184, 800 | 3, 000 | .0430 | |
| 197, 120 | 3, 200 | .0460 | |
| 209, 440 | 3, 400 | .0485 | |
| 221, 760 | 3, 600 | .0512 | |
| 234, 080 | 3, 800 | .0540 | |
| 246, 400 | 4, 000 | .0570 | |
| 258, 720 | 4, 200 | .0598 | |
| 271, 040 | 4, 400 | .0627 | |
| 283, 360 | 4, 600 | .0655 | |
| 295, 680 | 4, 800 | .0682 | |
| 308, 000 | 5, 000 | .0712 | |
| 320, 320 | 5, 200 | .0744 | |
| 332, 640 | 5, 400 | .0776 | |
| 344, 960 | 5, 600 | .0812 | |
| 357, 280 | 5, 800 | .0852 | |
| 369, 600 | 6, 000 | .0892 | |
| 381, 920 | 6, 200 | .0938 | |
| 394, 240 | 6, 400 | .0975 | |
| 428, 700 | ..... | ..... | Ultimate strength. |

**Time of test, 22 minutes.**
**Fibers crushed from 4″ to 8″ from end of specimen.**

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## COMPRESSION OF WOOD (OAK AND PINE).

*Compression tests of samples of yellow pine and white oak cut from round posts tested for Edward Atkinson.*

Specimens rectangular, 32″ long each.

### WHITE OAK.

Dimensions of original post: Length, 168″; diameter, 10″.54; sectional area, 84.8 square inches; diameter of core, 1″.75.
Ultimate strength, 420,000 pounds = 4,953 pounds per square inch.

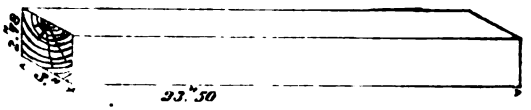
No. 621.

Sectional area, 20 square inches.
Weight, 17¼ pounds.
Ultimate strength, 169,000 pounds = 8,450 pounds per square inch.
Failed 6″ from end where the grain was wavy.

No. 621*a*.

### WHITE OAK.

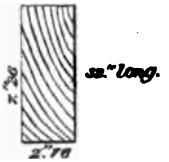
Specimen cut from No. 621.




Sectional area, 8.34 square inches.
Ultimate strength, 65,000 pounds = 7,794 pounds per square inch.
Failed at a knot 5″ from end.

No. 622.

Specimen cut from same post as No. 621.




Sectional area, 20 square inches.
Weight, 17½ pounds.
Ultimate strength, 137,000 pounds = 6,850 pounds per square inch.
Failed by opening a longitudinal seam along a row of knots.

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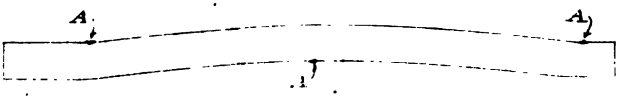
YELLOW PINE.

Dimensions of original post: Length, 167″.90; diameter, 7″.70; sectional area (mean), 45.8 square inches; diameter of core, 1″.60.
Ultimate strength, 200,000 pounds = 4,367 pounds per square inch.

No. 623.

Sectional area, 8.77 square inches.
Weight, 8 pounds.
Ultimate strength, 47,300 pounds = 5,390 pounds per square inch.
Failed by deflecting sideways, crushing fibers on the concave side at middle; also $1\frac{3}{4}$″ from one end and $4\frac{3}{4}$″ from the other end on the opposite side from the crushing at the middle, as indicated by letters *A* on the sketch.




No. 624.

Specimen cut from same post as No. 623.

Sectional area, 8.8 square inches.
Weight, 9 pounds.
Ultimate strength, 48,300 pounds = 5,490 pounds per square inch.
Failed by deflecting sideways, crushing fibers on the concave side.

YELLOW PINE.

Original post tested with one flat end and one round end.
Dimensions of original post: Length, 143″.04; diameter, 8″; sectional area, 48.25 square inches; diameter of core, 1″.60.
Ultimate strength, 225,000 pounds = 4,663 pounds per square inch.

No. 625.

Sectional area, 8.8 square inches.
Weight, 8 pounds.
Ultimate strength, 51,200 pounds = 5,820 pounds per square inch.
Failed by fibers crushing, stick taking a slight horizontal deflection.

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No. 626.

Specimen cut from same post as No. 625.

Sectional area, 8.8 square inches.
Weight, 8 pounds.
Ultimate strength, 58,000 pounds = 6,590 pounds per square inch.
Fibers crushed at a knot 9" from end of specimen.

WHITE OAK.

Dimensions of original post: Length, 164".08; diameter, 9".25; sectional area, 64.4 square inches; diameter of core, 1".90.
Ultimate strength, 221,000 pounds = 3,432 pounds per square inch.

No. 627.

Sectional area, 13.1 square inches.
Weight, 11½ pounds.
Ultimate strength, 63,100 pounds = 4,817 pounds per square inch.
Failed at a knot 10" from end of specimen.

No. 628.

Specimen cut from same post as No. 627.

Sectional area, 13 square inches.
Weight, 11½ pounds.
Ultimate strength, 81,000 pounds = 6,230 pounds per square inch.
Failed at a group of knots 8" from end of specimen.

WHITE OAK.

Tested with pintle ends.
Dimensions of original post: Length, 163".80; diameter, 9".35; sectional area, 65.8 square inches; diameter of core, 1".90.
Ultimate strength, 215,000 pounds = 3,267 pounds per square inch.

No. 629.

Sectional area, 13.19 square inches.
Weight, 11¾ pounds.
Ultimate strength, 79,900 pounds = 6,058 pounds per square inch.
Failed at a group of knots near middle of specimen.

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No. 630.

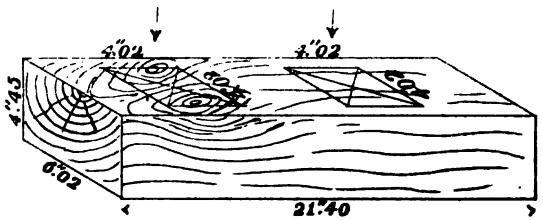
Specimen cut from same post as No. 629.

Sectional area, 13.08 square inches.
Weight, 11¾ pounds.
Ultimate strength, 80,900 pounds = 6,185 pounds per square inch.
Failed at a knot 6″ from end of specimen.

*Indentation of wood perpendicular to grain.*

No. 714.

WHITE PINE.




Compressed area, 4″.02×4″.02 = 16.16 square inches.
End A straight-grained.
End B compressed area covers two knots.
Cast-iron block pressed against wood.

END A.

| Loads applied. | Pounds per square inch. | Indentation. | Remarks. |
|---|---|---|---|
| *Pounds.* | | *Inch.* | |
| 0 | 0 | 0. | |
| 1,616 | 100 | 0. | |
| 3,232 | 200 | 0. | |
| 4,848 | 300 | 0. | |
| 6,464 | 400 | .01 | |
| 8,080 | 500 | .02½ | |
| 9,696 | 600 | .05 | 1/10″ indentation. |
| 11,312 | 700 | .46 | |

END B.

| | | | |
|---|---|---|---|
| 0 | 0 | 0. | |
| 1,616 | 100 | 0. | |
| 3,232 | 200 | 0. | |
| 4,848 | 300 | .01½ | |
| 6,464 | 400 | .03 | |
| 8,080 | 500 | .03½ | |
| 9,697 | 600 | .03¾ | |
| 11,312 | 700 | .04 | |
| 12,300 | | .05 | 1/10″ indentation. |
| 12,928 | 800 | .09 | |
| 14,544 | 900 | .15 | |



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## No. 715.

### WHITE PINE.

Size of specimen, 6″ × 4″.4 × 24″ long.
Compressed area, 4″.02 × 4″.02 = 16.16 square inches.
End A straight-grained.
End B compressed area covers knot 1¾″ diameter.

END A.

| Loads applied. | Pounds per square inch. | Indentation. | Remarks. |
|---|---|---|---|
| *Pounds.* | | *Inch.* | |
| 0 | 0 | 0. | |
| 1,616 | 100 | .01 | |
| 3,232 | 200 | .02 | |
| 4,848 | 300 | .02 | |
| 6,464 | 400 | .03 | |
| 7,800 | ..... | .05 | $\frac{1}{20}$″ indentation. |
| 8,080 | 500 | .08 | |
| 9,696 | 600 | .28 | |

END B.

| | | | |
|---|---|---|---|
| 0 | 0 | 0. | |
| 1,616 | 100 | 0. | |
| 3,232 | 200 | 0. | |
| 4,848 | 300 | 0. | |
| 6,464 | 400 | 0. | |
| 8,080 | 500 | .01 | |
| 9,696 | 600 | .01 | |
| 11,312 | 700 | .01 | |
| 12,928 | 800 | .02 | |
| 14,544 | 900 | .02¼ | |
| 16,160 | 1,000 | .03 | |
| 19,100 | ..... | .05 | $\frac{1}{20}$″ indentation. |

## No. 716.

### WHITE PINE.

Size of specimen, 6″ × 4″.4 × 24″ long.
Compressed area, 4″.02 × 4″.02 = 16.16 square inches.
End A straight-grained.
End B compressed area covers a knot 2¼″ diameter.

END A.

| Loads applied. | Pounds per square inch. | Indentation. | Remarks. |
|---|---|---|---|
| *Pounds* | | *Inch.* | |
| 0 | 0 | 0. | |
| 1,616 | 100 | 0. | |
| 3,232 | 200 | 0. | |
| 4,848 | 300 | .01 | |
| 6,464 | 400 | .02 | |
| 8,080 | 500 | .04 | |
| 9,696 | 600 | .05 | $\frac{1}{20}$″ indentation. |
| 11,312 | 700 | .14 | |
| 12,928 | 800 | .31 | |

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END B.

| | | | |
|---|---|---|---|
| 0 | 0 | 0. | |
| 1,616 | 100 | .00⅛ | |
| 3,232 | 200 | .00⅛ | |
| 4,848 | 300 | .00⅛ | |
| 6,464 | 400 | .00⅛ | |
| 8,080 | 500 | .01 | |
| 9,696 | 600 | .01 | |
| 11,312 | 700 | .02 | |
| 12,928 | 800 | .02 | |
| 14,544 | 900 | .02⅛ | |
| 16,160 | 1 000 | .03 | |
| 23,400 | ..... | .05 | 1/10" indentation. |
| 25,856 | 1,600 | .13 | |

## No. 717.

## YELLOW PINE.

**Size of specimen, 5".50 × 4".50 × 24".**
**Compressed area, 4".02 × 4".02 = 16.16 square inches.**
**End A straight-grained.**
**End B compressed area covers a knot 2¼" diameter.**

END A.

| Loads applied. | Pounds per square inch. | Indentation. | Remarks. |
|---|---|---|---|
| *Pounds.* | | *Inch.* | |
| 0 | 0 | 0. | |
| 3,232 | 200 | 0. | |
| 6,464 | 400 | 0. | |
| 9,696 | 600 | 0. | |
| 12,928 | 800 | .00⅛ | |
| 16,160 | 1,000 | .00⅛ | |
| 19,392 | 1,200 | .03 | |
| 21,080 | 1,300 | .03⅛ | |
| 22,624 | 1,400 | .04⅛ / .05 | 1/10" indentation. |
| 24,240 | 1,500 | .13 | |
| 25,856 | 1,600 | .18 | |

END B.

| | | | |
|---|---|---|---|
| 0 | 0 | 0. | |
| 3,232 | 200 | .00⅛ | |
| 9,696 | 600 | .00⅛ | |
| 16,160 | 1,000 | .00⅛ | |
| 22,624 | 1,400 | .01 | |
| 29,088 | 1,800 | .02 | |
| 39,100 | ..... | .05 | 1/10" indentation. |

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